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AVIATION

The Oldest American Aeronautical Magazine

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AVIATION

Est. 1916 McGraw-Hill Publishing Company Inc

The Oldest American Aeronautical Magazine

EDWARD P WARNER *Editor*

LOUIS F STOLL, *Publishing Director*

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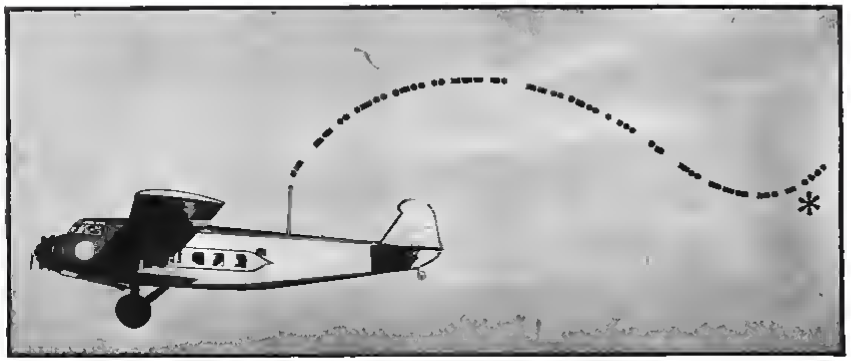

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AVIATION
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The Oldest American Aeronautical Magazine

EDWARD P. WARNER *Editor*

Volume 31 . . *November, 1931* . . Number 11

Aviation and the American economic system

WE who are actively engaged in aeronautical work are often accused of over-enthusiasm. Even the most conservative of us are likely to be suspected of putting too favorable an interpretation upon our figures, and of over-estimating the effect that flying should have upon the community. When we appeal to Congress, or to any other public body, for assistance in one form or another we are likely to be told that ours is simply another special interest, that we can expect no special favors, and that we must take our chances in the arena of business and battle for the consumer's dollar along with the cloak and suit industry and the kitchen ware industry and the bicycle and buggy industries. As we write this editorial, there lies upon the desk before us a letter in which a gentleman of great position and of universally admitted originality of view and forthrightness of expression asks the question: "If the aviation industry is unable to support itself without having to worry about governmental action why should it not collapse and disappear, as a hundred other industries have done under similar circumstances?"

It is a perfectly fair question. It is one to which we must find an answer, and we must answer it without allowing ourselves to be influenced by our own enthusiasm. The mere facts that we who are in the business are devoted to it,—that we think it interesting above all other human concerns,—that many people find in aeronautical engineering the most engrossing of sciences,—and that many others are passionately devoted to flying for its own sake,—those are not answers. We must reply from the point of view of the man who cares nothing about aviation. We must look into the fundamental social and economic effects of our own activities.

We have often called attention to the importance of high-speed transportation to modern business. It is the very life of a democratically governed nation extending over a vast area. We have taken occasion to remark that the very possibility of existence of the United States, extending 3,000 miles from coast to coast, has been bound up for 70 years with a few slender ribbons of steel across mountains and prairie and desert. The transportation system that the railroads created has now been rendered more efficient and more flexible, and generally more useful by the introduction of the airplane. For thousands of years, at least since the famous Roman roads were built, governments that have thought of giving assistance to the development of the economic machine have turned their attention first to the improvement of communication. The support of air transport, even without the slightest reference to the military value of the airplane, was in strict accordance with an unbroken tradition of immense antiquity.

But for our present purpose that serves only as the introduction. There is much more to be said. The potential effect of the airplane upon our civilization is by no means limited to getting men and their goods and their letters from place to place more rapidly than in the past. There is another factor, peculiar to the last 40 years and attaining its greatest significance in the United States.

We are today at a cross-roads where serious and thoughtful men are threatening us with a total breakdown of civilization as we have known it. We have gone on for a generation building a rapidly expanding industrial machine, and absorbing into new industries the labor displaced from the old ones by the introduction of new and more efficient machinery. Every depression

has seemed to mark the end of that whole cycle of industrial advance. From every depression, we have been led out into new prosperity by the appearance of new industries. It is no exaggeration to say that the growth of the automobile business carried American economic progress for twenty years. The automobile reached its limit of rapid expansion in 1929. From that industry, looking back upon 30 years of growth without precedent in economic history, the torch must be passed on to a fresh runner in the race. If we want to go on with the same kind of life and economic organization that we have had in the past, we shall have to find a leader for the next lap. C. F. Kettering lays the alternatives clearly before us. "The question is whether we are going to go on building America, or just going to operate it."

It is not only the aeronautical enthusiasts who pick aviation as a strong candidate for the next leadership. Stuart Chase, who is an economist without specialized aeronautical experience, and who has concerned himself with the airplane principally as a military menace, sums up a rather gloomy review of the outlook with: "What will take the place of the automobile industry? A fool-proof airplane might do it, but where is the fool-proof airplane?" With due reservations on the word 'fool-proof," which does not accurately describe any piece of machinery that has ever yet been built, we assure Mr. Chase that he need not yet abandon hope of the airplane.

Far from it. Despite disillusionment from the bright visions of 1929, the airplane remains among our best industrial prospects. But the industry's potentialities for the future depend upon its surviving the worst stages of the present crisis without too much damage or loss of morale.

The rise of manufacturing industries, of which the building of automobiles is the most conspicuous but by no means the only example, has created our present industrial structure. Even those whose employment has never been directly connected with the automobile industry, and who have never owned a car or made regular use of one, have profited immensely from the expansion of automobile manufacture. In the same way, the airplane redounds to the universal advantage, not merely to that of its immediate owners or users. But the possibilities of future benefit to the American people could suffer a very serious set-back at the present time. There *must* be a reasonably liberal governmental policy towards aviation in the next couple of years. There *must* be no sudden and violent contraction of government orders for aircraft. Air transport *must* have firm support from the Post Office Department for at least two or three years more. Research work, both as directly carried on by various agencies of the federal government and as indirectly stimulated by its military branches, *must* continue. Those are fundamental conditions to be met if the industry is to retain the advantage of what has already been expended and done, and to maintain continuity of progress towards a great future. Whatever happens, the aircraft industry is not going to be destroyed, but it can suffer some grievous blows in the next six months. The budget that the President transmits to Congress in the first week of December and the action that Congress takes upon it in the months immediately following will go far to determine whether or not we must set the concise and colloquial epitaph, "All washed up," upon a great part of the fruits of fifteen or twenty years of effort.

Dwight W. Morrow

'When that great kings return to clay
Or emperors in their pride,
Grief of a day shall fill a day
Because its creature died;
But we, we reckon not with those
Whom the mere fates ordain,
This Power that wrought on us now goes
Back to the Power again."

NOT in a dozen years has there been such general and sincere sorrow, or such a universal realization of irreparable national loss, at the death of an American citizen. He had come from a great financial institution in New York, and within a few months he had gained the unqualified trust and affection of statesmen to whom the very name of Wall Street was anathema. Above the ordinary run of men, whether in business or in public life, he stood out like the peak above the plain.

We in aviation share the national mourning for Senator Morrow, but we have special reason to mourn him on our own account, for we had a special claim upon his interest. When he first turned from banking to public affairs, his first responsibility was the chairmanship of the President's Aircraft Board. As his political career began, so it ended, for upon the very day of his death he was to have met with a group of air transport operators who sought his counsel upon their problems.

One had to work directly with the Morrow Board, as it was our privilege to do, to realize to what an extent the accomplishments of the board were the personal accomplishments of its chairman. He came to his work as the head of that very able group of men at a time when American aviation was torn by dissension and when cries of graft and incompetence filled the air. Justifying his business reputation as a matchless negotiator and a master of compromise, he left the sweet light of reason in his wake, and the board over which he presided laid in its report the foundations upon which the whole air policy of the last five years has been built.

Another man, and a lesser one, might have been content to bask in the light of his own past achievements, or would at least have been prone to prevail upon them to the extent of continuing to accept the status of an aviation authority and a specialist in the aeronautical field. Dwight Morrow was not built that way. His concern was always with what he was going to do next, not with what he had been able to lay down as a completed task. His interest in aviation remained keen, but it was one interest among many, and he had no desire to be complimented for what he had done. He was a great man. We shall miss him often and badly, in the next few years.

Pan American again to the rescue

SAID *Time*: "As usual in Central American catastrophes, Pan American Airways got the news out to the world first." Said a despatch from an airways radio operator, who had been on duty for 108 consecutive hours at the time of sending it: "Suddenly the light over my desk went out. Roofs were being torn off. The crash of wood and the ripping of timber rose to a din. All night we were working frantically to get the station back in order, retrieving parts from all over the yard. It was a matter of life and death. A roof was hastily rigged, and the telegraph key was screwed into place." Said the first message that he sent: "Belize destroyed by hurricane. Two hundred dead." Said a news despatch, a couple of days later: "A Pan American Airways plane was being loaded at Havana with anti-tetanus and para-typhoid serum, morphine tablets, and antiseptics. It was reported ready to leave late in the afternoon." Said the governor of Belize: "The colony is under a deep debt of gratitude to the Pan-American Airways, Inc., whose ready and willing assistance and cooperation has enabled the government to get into touch with the outer world."

All of which comes as a new and vigorous reminder of the extent to which the world to the south of us is being remade by air transport organized under the American flag. We who live in the temperate zone know air transport as an addition to a system of transportation already highly organized, an exceedingly valuable addition but not an absolutely indispensable one. In those countries where for various reasons surface transport has been organized more slowly or not at all, the airplane has a very different place. It has become an essential part of their lives. With only three years of air transport history upon the books, it is already as impossible for them to conceive of getting along without the airplane as for us to imagine doing without telephones and electricity.

The planes and the air transport organization that has been developed are always to the fore, as in Belize last month and in Santo Domingo a year ago, when disaster occurs. Their services in normal times are less spectacular but equally important. A gentleman having no connection with and no interest in aviation, but very much interested in the social and political development of the Caribbean peoples, wrote a few months ago to say: "Without being actually upon the ground, it is impossible to conceive of the effect that air transport has had down here. Journeys that took many days are now a matter of hours and a very few hours at that. The whole region has gone at a bound from the most primitive transportation imaginable to the most advanced, and men whose whole lives were geared to the burro or canoe, and for whom five miles an hour was fast travel, are now using the airplane as a matter of course. It is literally true that there are people who never had seen an automobile until after making their first flight in an airplane."

We are not spending all this space merely to extol an accomplished fact or to laud those responsible for its accomplishment. At a time when the whole world is applauding the services of a transport line, and when those most directly benefited by the line's prompt action in disaster are profuse in their gratitude, it is worth while recalling some of the obstacles that have existed to the international development of aviation. Government and colonial offices have wanted to reserve air transport privileges for their own nationals. The colonies of European powers on this side of the Atlantic (although on the whole the action of the governments concerned has been infinitely more broad minded and open-handed here than in the eastern hemisphere) have sometimes been used as pawns in the development of a national and imperial air policy. If there is one great lesson that the Belize hurricane has to teach, it is that all the peoples of the world, and especially those of countries that have been comparatively retarded in their economic development, need air transport far worse than they need any national advantage, and that they had better take it upon any terms immediately available. We venture to deduce from the generous expressions of the governor of Belize that he and the British residents of the colony over which he presides are very glad indeed that a broad and generous policy of air transport development in that section of the British Empire has prevailed. It had to make headway against the counsel of a few short-sighted seekers after special advantage who would have forbidden any sort of air transportation in any British colony in which Imperial Airways was not yet ready to start activities. While lamenting the terrible loss of life in the hurricane and the property damage done, the whole American aeronautical community must feel some gratification that it has been possible for an American airline to give such prompt and efficient help in disaster and to furnish so cogent an example of the importance of a free development of transport flying on international lines.

The second thought that comes to mind concerns ourselves. There have been occasional attacks, on

grounds of economy or for other reasons, against the whole air mail framework, domestic and foreign. The domestic mail service can stand on its own feet, for it is being so widely used by American business that hundreds of thousands of our people are intimately acquainted with its value and have come to depend upon it. Not so many of them make contact with the foreign mail, or realize just why American planes are running, at a certain cost to the American Post Office, across the Andes and over the mouth of the Amazon. The Belize hurricane comes as another reminder that, even if American business derived no direct advantage at all from air mail communication with its markets to the south, the air mail would still be worth while. Its services to American diplomacy and the American government in the promotion of friendly relations among the nations would very fully justify all the deficits that have had to be incurred since the Foreign Air Mail Act was passed.

Riding comfort

THE habitual traveler, having frequent occasion to make use of all forms of transportation, may feel that it is foolish to discuss comfort on airlines. Under most conditions they are already far superior to any other form of transportation. Travel 500 miles in summer by air, and then return by rail, with the whistle shrieking, cinders shifting in through the screen to corrode your throat and ruin your clothing, and the wheels making cacophony on the rail joints and switches, and you will be convinced that the air transport companies have little for which to apologize.

Nevertheless, there always remains room for improvement, and in some cases the characteristics of the transport airplane are definitely bad, not as compared with the railroad and motor bus but with what we know they might be. Some of them have irritating vibrations of the whole structure or of some cabin furnishing. Some have seating so congested, or seats so uncomfortable in form, that it is torture to occupy them without opportunity for appreciable change of position for several hours. In some cases ventilation is an unsolved problem, and the passenger has a choice between accepting a complete lack of fresh air and being hit in the face with a jet of air as concentrated as a stream of water from a hose. And then there is always the question of bumps, which cannot be ironed out completely, but which are much more noticeable and disagreeable on some types of planes than on others. Flying qualities and the comfort of the passengers are, as Mr. Courtney has pointed out in his articles in AVIATION, inexplicably inter-connected.

The real problem in connection with all these matters is the effect on the passengers. A very rough measure is furnished by the percentage of air-sickness. It is of course exceedingly low in all cases but a traveler by air may have a strong enough stomach not to become airsick and still get so disagreeable and fatiguing an impression from an air journey that he will not want to make another. The test of success is not merely that the passenger shall be able to walk away from the plane after alighting, but that he shall feel fresh and ready to go about his business at the end of a long flight.

That seems easy enough to determine, but unfortunately it is exceedingly difficult. The passenger's reply to direct inquiry is complicated by innumerable factors, including his desire, or otherwise, to be amiable and his wish not to confess to weakness or to have it thought that he was timid about flying. What we need as an instrument of research is some means of finding out how the air traveler feels at the end of a trip without asking him.

Fortunately the problem has been largely solved for us. The automobile industry has met the same difficulty in its attempts to get quantitative measurements of the riding comfort of a car, and to eliminate the factor of human emotion. Through the Society of Automotive Engineers they have called into counsel Dr. F. A. Moss, George Washington University psychologist, and Dr. Moss has evolved the answer in an instrument going by the mysterious name of "wabblemeter." It requires only that the passenger undergoing the test stand stationary on a small platform for about a minute just before starting the flight, and do the same thing again on completing it. It takes into account everything—noise, vibration, uncomfortable seating, and all the rest,—that affects the passenger's comfort.

Although research is ordinarily carried out in the laboratory or at a flying field devoted to the purpose, there are some investigations that can only be made under actual transport conditions. In their own interest the airlines should cooperate as freely as possible in any investigations not handicapping their operations. They are already cooperating in the analysis of the loads imposed upon the airplane structure by bumps, and the planes of a number of transport lines are now regularly carrying accelerometers provided by the National Advisory Committee for Aeronautics to measure the loads. There is another opportunity here, requiring only that an occasional selected passenger be invited to volunteer for the very simple test outlined in the previous paragraph. We suggest that the air transport lines, either upon their own initiative or under the guidance of the N A C A, draw upon the experience of the automobile industry and upon the work of Dr. Moss. Not only shall we then be able to determine the effect of specific changes in seating or ventilation or any other particular feature of passenger accommodation, but we shall be able to compare directly the comfort of air travel and of travel by surface means. Unless we are very much mistaken, the transport lines will thereby gain some interesting bait to be used in angling for brand-new recruits to their passenger lists.

News of the Month

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The Schneider aftermath

WITH Flight Lieut. G. H. Stainforth's achievement on Sept. 29 of an average speed of 408.8 m.p.h. in four flights over the 3-km. course at Calshot, Britain retained world speed supremacy. One lap was covered at 415.2 m.p.h., with a light wind. Stainforth flew one of the S.6B Supermarine planes built for the Schneider races, powered with a special Rolls-Royce engine developing 2,560 hp., some 300 more than was possible in the engines used a few weeks earlier, and equipped like every other Schneider winner since 1926 with a Fairey-Reed propeller originated by an American, Dr. S. A. Reed. The specially refined fuel contained both tetra-ethyl lead and a high percentage of wood alcohol, the latter an ingredient frequently used in motorcycle racing in England but unknown outside the laboratories in this country.

This probably drops the final curtain on contests of the Schneider order, for a typical expression of British opinion now is that "it seems to be generally agreed that the Schneider Trophy has outlived its usefulness, and that in the interests of all the nations concerned it is desirable that there should be no more of these particular contests." There is a possibility, however, that Italy may stage an epilogue, for reports have been continually coming from that country of the development of a plane capable of 450 m.p.h. The plane in which Flight Lieutenant Bellini was killed on Lake Garda a short time ago was reported as having attained 453 m.p.h., but there was no official corroboration.

Across the Pacific

To better the 'round-the-world speed record of Post and Gatty was the aim of Clyde Pangborn and Hugh Herndon when they took off from Floyd Bennett Field on July 28. After their trans-Atlantic hop a series of disasters culminating in their arrest by the Japanese government for flying over and photographing fortified areas without permit forced them to change their objective to a non-stop trans-Pacific flight, with a possibility of establishing a new distance record. Two months of legal argument intervened before they were able to hop off in their Wasp-powered Bellanca plane from Sabishiro Beach, some 375 miles north of Tokyo, with 915 gal. of gasoline, 45 gal. of oil, and emergency rations for 30 days, a total weight of about 9,000 lb. and almost a record loading for a plane of 309 sq.ft. wing area. Forty-one hours and 13 min. later Pangborn skidded a wheelless plane to a landing at Wenatchee, Wash., all landing gear having been dropped into the ocean soon after the take-off, an expedient to reduce parasite air resistance adopted on several of the trans-Atlantic attempts made in 1919. Though their 4,588-mile flight lacked more than 300 miles of the Boardman-Polando record it goes down in history as the first non-stop crossing of the Pacific by a heavier-than-air plane.

Records withstand assault

Other aspirants to new records have been less fortunate. The second attempt of three French aviators to raise the world's distance record in a flight from Paris to Tokyo ended fatally. When an explosion in the engine tore their plane to pieces in midair over Siberia, about 700 miles east of Moscow, Joseph Le Brix, companion of Costes in the first non-stop flight across the south Atlantic, and Rene Mesmin fell with the wreckage and were killed, while Marcel Doret was thrown clear, and escaped by his parachute.

Wide World

ALOFT

The U.S.S. Akron on its maiden flight over eastern Ohio

Willy Rody, Christian Johanssen, and Fernanda Costa de Vega were picked up off the coast of Newfoundland more than a week after they had started from Juncal do Sol, Portugal, for New York to demonstrate the navigability of the Atlantic. Their all-metal Junkers plane, similar to the "Bremen" in which Fitzmaurice, Koehl and von Huenefeld flew from Ireland in 1929, floated 148 hours after lack of fuel had forced a landing on the ocean more than two-thirds of the way to their destination. Storms and headwinds and the failure of a sparkplug, causing the engine to run on five instead of six cylinders, combined to exhaust in 36 hours the 635 gal. of gasoline which should have carried them 48.

Maj. James Doolittle, who recently topped Capt. Frank Hawks' west-to-east transcontinental record, has begun to offer him competition in city-to-city record making. He flew from Ottawa to Mexico City, via Washington, in 12 hours and 36 min. elapsed time.

After several weeks of rest and sightseeing in and around Tokyo, Col. and Mrs. Charles A. Lindbergh continued their trip across the Inland Sea to the southern island of Japan and Fukuoka and thence by an 800-mile flight to Nanking, China. At Nanking the Colonel substituted for the usual official entertainment program a series of aerial surveys of the areas to aid the government in its extensive relief activities. Continuing their surveys in the region of Hankow, Colonel and Mrs. Lindbergh were accommodated abroard the British aircraft carrier Hermes, probably the first occasion on which the veil of military secrecy which surrounds aircraft carriers in all navies has been lifted to offer a base of operation to a foreign plane.

Equally well-known on the European continent as aerial tourists are the Comte and Comtesse de Sibour, who circled the world in their plane several years ago and who as a finale to a vacation in China flew from Peking to Paris in eight days. The Comte and Comtesse, with a guest and a mechanic

aboard, made what is practically a record trip, despite adverse weather conditions which caused several forced landings. A Farman 190 with a 300-hp. Gnome-Rhone engine has supplanted the Moth plane in which they visited the U. S. on their world tour.

Airplanes abroad

An early flight across the North Atlantic by an Italian fleet of 24 military flying boats is planned by Air Minister General Italo Balbo, who led a fleet of airplanes to South America in mass flight last January.

The successful completion of a test cruise from Plymouth to Port Sudan and back, ending with a 1,230-mile non-stop flight from Gibraltar is the record of the 1,500 hp. Saro *7*, one of the new flying boats submitted to the British Air Ministry for use by the Royal Air Force. With a crew of six 8,324 miles, largely in tropical waters, were covered in about 90 hours of flying time. In further accordance with the present British policy calling for the development of large aircraft able to fly long distances without descent for fuel is a 45-passenger flying boat now under construction at the Supermarine Aviation Works. Fully loaded with passengers and mail it will weigh 35 tons and have a range of 1,300 miles at a top speed of 150 m.p.h.

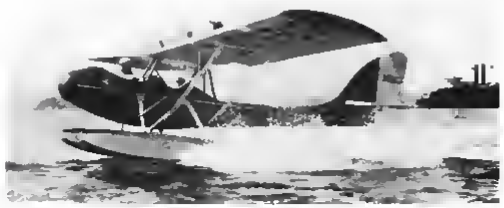
A champion of air preparedness has arisen in Japan. In a Japanese publication, *Chuo Koron*, he points out that Japan stands only sixth among the Powers in number of military airplanes, while its position as regards civil aviation is even further down the scale. He put the United States second in military strength. One thousand military planes, 1,100 civil planes and 1,311 miles of commercial airways are the figures which are scored as inadequate.

A Brazilian Army airplane, the Duque de Caxias, now on the west coast of South American on a goodwill flight, has been authorized to continue its trip to New York, by way of Peru, Colombia and Florida.

The Air Corps' kindergarten

Cross-country formation flights of more than 100 planes from the primary school at March Field at Riverside, Cal., initiated activities at Randolph Field, the new primary training center near San Antonio, Tex. Randolph Field, one of the greatest peacetime projects ever undertaken by the federal government, is a departure from the usual Air Corps post design in that all activities radiate from the center, where hangars, shops and quarters are located instead of in the usual position along one end of the landing area.

The flying activities of the National Guard are being restricted to some extent due to the need for rigid economy. Beginning Oct. 1 each squadron will be limited to 112 flying hours per month,



LIGHT PLANE TAKES TO WATER

A Curtiss-Wright Junior equipped with Edo floats running on the step. This machine was reported to show satisfactory performance as a seaplane carrying two 180-lb. pilots and a full tank of gasoline.

eight hours for each of the authorized fourteen pilots.

The Army's 1930 record for total flying time without accident is credited to Lieut. Thad V. Foster, Airway Control Officer of the 8th Corps Area at Fort Sam Houston. During 1930 he flew 1,019 hours without accident, an average of nearly three hours a day. During the four years in which the Schiff Trophy was awarded to the naval aviator showing the greatest flying time without accident Lieutenant Foster's record was exceeded only once—by Lieut. James E. Dyer, who flew 1,215 hours during the fiscal year 1929.

Another worthy performance by the Army Air Corps was recognized by the award of the Mackay Trophy. Considered the most outstanding and meritorious flight during 1930 was a mid-winter aerial jaunt led by Maj. Ralph Royce, who took the First Pursuit Group from Selfridge Field, Michigan, to Spokane, Wash., and back in January, gaining valuable information about the operation of airplanes and personnel while under severe winter conditions.

Navy in new fields

The Navy's first flying experience on a large scale with winter weather will come this year, as a result of criticism of the policy of staging maneuvers in waters where machines run easily and nothing freezes. The airplane carrier Langley will be sent into northern waters where planes may be flown on and off icy flight decks and the efficiency of pilots and deck personnel, hampered by heavy winter clothing, may be tested.

An order unique in Navy Department history, but common practice abroad, is a reservation of air-space and sea area in the region of Tangier Sound in Chesapeake Bay, a little north of Annapolis, from Oct. 5 to 10, inclusive. Aircraft were prohibited from operating within a radius of five miles and surface craft within a radius of two miles of the center of the area where bombing tests, to which only War and Navy department observers were invited, are being conducted on the obsolete cruiser Pittsburgh.

New planes and new pilots

Spectators at Tempelhof Aerodrome were impressed by tests of a tailless plane on which Alexander Lippisch, well-known German glider constructor, has been working for several years. Named after the trans-Atlantic flier, Capt. Hermann Koehl, who financed its construction, this innovation measures 42 ft. from wing tip to wing tip and has a surface area of 262 sq. ft. and a 30-hp. engine. The reported speed of 90 m.p.h. and ceiling of 14,000 ft. were far better performance than would have been predicted from the reported power, area and weight.

Among recent contributions to the safety of night and blind flying is a combination radio transmitter which will furnish for aviators a satisfactory radio telephone for weather broadcast information as well as uninterrupted visual range-beacon signals. A sextant which enables a navigator to determine the altitude of the sun above the horizon regardless of weather conditions or visibility of the sun by detection of its infra-red radiation, has been invented by an American engineer Paul Humphrey MacNeil. The instrument, consisting of a sextant proper and an amplifier, performed in a variety of weather conditions to the satisfaction of a group of officials of the British Air Ministry and the admiralty at Croydon.

A new aviation fuel was used by Maj. James Doolittle in his record Los Angeles to New York flight. Heavier in weight and giving more B.t.u.'s per gallon than ordinary gasoline, the new fuel was developed in the laboratories of the Shell Petroleum Corporation, of whose Aviation Department Major Doolittle is director.

A mechanical piloting device which relieves the human pilot of almost all flying operations except take-off and landing was successfully demonstrated on Oct. 7 to a group of officials of the Aeronautics Branch in an eighteen-

passenger plane of the Eastern Air Transport. Developed by the Sperry Gyroscope Company for use by the military forces in guiding heavy bombing planes on long night raids, this is the first instance of its use in a transport plane. The device is a lineal descendant of an automatic pilot developed by the late Lawrence Sperry in 1911 and given spectacular demonstration by him at that time. By means of small gyroscopes controlling a clutch relay, which in turn operates the controls as a pilot would, the plane is not only maintained in level flight, but also is held to the constant compass course to which it is set on a directional dial. All deviations caused by air currents or shiftings of weight within the plane being corrected almost as soon as they are started. According to present plans as soon as it has been approved by the Department, the Sperry pilot will be made a part of the regular equipment of Eastern Air Transport's planes.

Ludington Line reports a profit

Among the other innovations which Ludington Line has introduced in the passenger transport field is an annual report covering the first year of operations ended early in September, which shows a profit. The company states that gross revenue for the year amounted to $576,885.86, that total expenses—including operating, traffic and general expenses, overhead, maintenance, taxes, and depreciation—amounted to $568,812.25, leaving a profit of $8,073.61. The company's Stinson tri-engined transports were flown 1,523,569 mi. on 8,300 trips between New York City and Washington and between Philadelphia and Atlantic City, at a gross cost of approximately 37½ cents per mile. The new extra-fare high-speed service, flown non-stop with Lockheed Orions between New York and Washington since Sept. 15, is reported to be well patronized. The company carried 29,169 passengers during the first six months of this year more than any other American company.

Century Airlines and Century Pacific Lines, companies inspired by Ludington methods continue to figure prominently in airline developments in the central West and Pacific Coast areas.

Rates continued to drop on the Pacific Coast during September. Century Pacific cut the one-way fare between San Francisco and Sacramento to $3.45 (4.6 cents per mile). On the Los Angeles-San Diego service Century is charging 4.3 cents per mile and Gilpin Air Lines has cut its rate to 3.9 cents per mile from 5.2 cents.

While Gilpin competes with Century in the south with fare reductions the Varney lines are challenging Century with a new high speed service on the San Francisco-Sacramento line originally developed by Varney, with Stinson Juniors. When Century cut its rate on this line, Varney ordered three Lockheed Orions for not only that run but also the San Francisco-Los Angeles route, thus competing with Century. United Air Lines and Transcontinental & Western Air. Planes on the latter route cover the distance in between 3 and 4 hours, while Varney proposes to cover it in 1 hour 58 min. The Sacramento run will be reduced to 22 min.

Unperturbed by the upheaval it has caused in Pacific Coast air transport circles, Century continues to expand its routes and schedules. There are now eight planes each way daily between Los Angeles and San Francisco. Service was extended from San Francisco to Sacramento early in September, from San Diego to Phoenix on Sept. 19, and on Oct. 3 the coast line between Los Angeles and San Francisco by way of Santa Barbara, Santa Maria, Salinas and San Jose twice daily. The company's original twelve schedules daily have been increased to a total of 36 counting all divisions.

Century Pacific's report of its first quarter shows 4,103 passengers carried and 756,634 passenger miles flown during July; 5,903 passengers and 836,045 passenger miles during August, 4,494 passengers and 849,870 passenger miles during September. There have been no mishaps. The operating department announces average operating costs of the Stinson tri-engined equipment to date, including all charges as 32.4 cents per mile.

Century Air Lines, operating in the Mid-West, carried 7,512 passengers during September, bringing the total carried since the service started on March 23, this year, to 40,213.

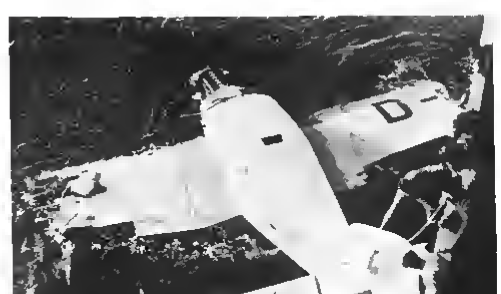
Air traffic increases

Accompanying a growth in miles flown by the transport companies, mail and express shipments increased during the first six months of this year over the volume for that period last year.

Imperial Airways planes were flown 531,790 miles between April 1 and Aug. 1 this year as compared with 500,293 miles in the same period last year, and receipts amounted to $1,188,310 as compared with $1,117,245. The company is speeding up its service to Karachi, India, by routing the planes from Athens to Haifa, Palestine, by way of Cyprus instead of from Athens to Egypt by way of Crete. This will provide six-day service between England and India instead of a seven-day schedule. The African service will continue to follow the former route across the Mediterranean. Inauguration of the Kenya-Cape Town extension has been postponed to January.

Corporation Aeronautica de Transportes in which has headquarters in Torreon, Mexico carried 4,421 passengers in its Lockheeds during the first six months of this year as compared with 2,283 in 1930. The mail increased to 18,854 lb. from 9,854 lb.; express and freight to 352,000 lb. from 3,129 lb.

A Lockheed Orion with metal fuselage has been delivered to Transcontinental & Western Air for experiment with high speed service on its lines. American Airways is putting the new Pilgrim nine-place, Hornet-powered passenger and mail transport into serv-



AFLOAT 158 HOURS

The gasoline tanks in the wings provided the necessary buoyancy for the Junkers Transatlantic Monoplane "Esa," to remain afloat 158 hours. The above photograph shows the condition of the structure at the time of rescue. Stability on the water was excellent.

ice on the Cincinnati-Indianapolis-Chicago route.

Eastern Air Transport is experimenting with Condors on the Richmond-Atlanta run, formerly covered exclusively with Kingbirds. The two types will be alternated over the route and, if patronage justifies, the Condors will be permanent equipment. Condors have been used between New York and Richmond for some time. The company on Oct. 15 inaugurated a special round trip rate of $20 for the New York-Washington service.

Salary cuts have been made again by T. & W. A. applying to all personnel. The pay for first pilots will henceforth range from $4,200 to $7,000 per year.

Second rate revision under Watres Act

Effective Oct. 1, the air mail compensation rate was revised for the second time since the Watres Act became operative. The cut is expected to care for about $700,000 of a possible $900,000 deficit forecast under the former rate. The saving is to be achieved by reducing the base rate when the minimum space contracted for is not filled with mail. That is, under the Watres Act the Post Office Department has contracted with each company for a minimum weight space, and pays a base rate for it, plus certain variables. If the weight of mail increases half way toward the next weight classification in the rate scale, the base rate is increased. The plan now is to decrease the base rate when the poundage falls below the minimum weight half-way to the next classification level, providing for a scaling downward as well as upward. A number of operators are understood to have been carrying loads not requiring the minimum space.

In the wake of recent expressions of dissatisfaction on the part of independent operators with the Post Office Department's methods of awarding air mail contracts and the organization of these independents into an association for purposes of protest, there is in process of formation the Pioneer Transport Operators' Association, a group composed only of the companies now holding air mail contracts. The director of the new group is Harry Collins, a former Navy officer who has been with Curtiss-Wright in the West.

This year's excellent record with ship-to-shore air mail ended tragically just before daybreak Oct. 6 when the Bremen's plane crashed in a bay about 60 miles northwest of Halifax. Fritz Simon, the pilot, and Rudolph Wagebeck, the mechanic, were lost. The pair had left the Bremen Oct. 5 when the steamship was about 650 miles from Sydney, N. S., and landed successfully at Sydney after negotiating an area of extremely bad fog. They refuelled and had gone about 190 miles farther on their course when the accident occurred.

On Sept. 23, various airlines observed the twentieth anniversary of the first official transportation of air mail by Earle L. Ovington in 1911 during an air meet at the old Nassau Boulevard field. He participated in the observance by flying east from Los Angeles in an American Airways plane on that day. At the same time the course he flew in 1911 between the Nassau Boulevard Field and Mineola, L. I., was flown by an American Airways Pilgrim.

British air mail grows

Growth in air mail volume in this country during the second quarter of this year has been paralleled by a growth in the volume of British air mail. Imperial Airways carried 27,996 lb. in April, May and June as compared with 20,634 lb. in the same period last year, a 36 per cent increase. The bulk of the loads (11,434 lb.) was on the Indian service. There was a decrease in poundage of parcels carried from 43,200 in 1930 to 40,327 this year. The British post office has begun to publicize the air mail services by means of gummed labels giving rates and nature of services available, an innovation in British air transport circles.

The Amsterdam-Batavia service operated fortnightly by K.L.M. for a year was stepped up to a weekly interval on Oct. 1. Fears that the Mexican mail services might be abandoned by late October for lack of funds have been dissipated by the official announcement that the government considers the services indispensable and that provision will be made by the treasury to enable continuation.

Coincident with the inauguration of passenger service by Pan American Airways between Santiago, Chile, and Buenos Aires, Aeropostale has resumed mail service between the two cities after a short suspension. Operations are now being directed from the Paris office of Aeropostale, rather than by the South American subsidiary which formerly had it in charge.

New equipment for the airways includes an order from the Westinghouse Electric & Manufacturing Company for about 50 double-end rotating beacons of higher candle power than the previous standard. Each beacon stands 5 ft. high, including the base the lens is 36 in. in diameter and there is a 1,000-watt lamp. Some of these beacons cast a white light from each end, while others show a white beam from one end and a red or green one from the other. The red warns the pilot there is no available landing place in the vicinity while the green indicates an emergency field is available.

Survey of the proposed northern transcontinental airway through the Northwest, under a special Congressional appropriation of $20,000, has been completed by Department of Commerce engineers. A report will be made during the next session of Congress.

New airport projects get under way

Among the largest of new airport construction projects is the development of Shushan Airport, New Orleans. About 4,000 ft. of the 6,000-ft. bulkhead, which will enclose the 320-acre tract being built entirely of fill in Lake Pontchartrain, has been completed and all specifications have been completed by the National Airport Engineering Company. Buildings to be erected in time for commissioning of the field in the late spring will cost about $344,000 and will include a 300x70-ft. administration building, a 200x120-ft. and 300x120-ft. hangar, 100x120-ft. repair building and an emergency and storage building.

Two engineers who have been investigating the construction to date on the Baltimore municipal airport project report that the design was faulty and the cost so far much greater than would have been involved at other sites, because of the tremendous amount of fill required. They recommend, however, the completion of the building program along revised lines, a work which will require three more years and cost an additional $1,400,000. The bulkheads came in for much censure, their cost being $170 a line foot in some places. The mud fill used has proved too soft in a number of areas.

Work on the Hog Island project at Philadelphia seems to be at a standstill. In reply to Chamber of Commerce requests for further immediate development work, the mayor has declared that no funds are available at present. The preliminary $1,000,000 loan has been virtually exhausted in clearing and foundation work.

MONOPLANE BOMBER

The new low-wing Boeing bomber, powered with two Pratt & Whitney Hornets, built for the Army Air Corps.

Improvement projects include a marine base at Floyd Bennett Field, Brooklyn. About $150,000 have been spent on bulkheads, fill and a ramp 220 ft. long and 50 ft. wide. Each of two seaplane hangars to be built will cost $200,000 and measure 300x114 ft. Half of the $300,000 improvement program at Love Field, Dallas which includes installation of runways, taxi strips, additional drainage and a $50,000 administration building, has been completed. National Air Transport is to build a 121x143 ft. steel and brick hangar at the field. A second steel and concrete hangar costing about $70,000, has been completed at the Denver Municipal Airport.

Transamerican Airlines Corporation has started construction of a $75,000 hangar, shop, and office building, measuring 100x150 ft. at the Chicago Municipal Airport. The company will move into it from temporary quarters in the American Airways hangar about Nov. 15. American Airways has commissioned the Austin Company to build a $150,000 steel and brick hangar at the Chicago airport. It will be 200 ft. long, 120 ft. wide and have a clearance of 22 ft.

Duluth Municipal Airport and the Duluth Boat Club have been designated airports of entry for one year.

A union of pilots engaged in airline operations has been organized at Chicago under the leadership of David L. Behncke, a Boeing System pilot. Among the transport companies whose employees are members are Northwest Airways and Transamerican. The union is affiliated with the American Federation of Labor. An earlier attempt to form a pilots' union failed to make any headway and came to grief about two years ago.

Dress rehearsals for the Akron

While the Graf Zeppelin shuttles back and forth across the south Atlantic the latest and largest development in airship design has been making the test flights prerequisite to its acceptance by the U. S. Navy. Shortly after dusk on Sept. 23 the U.S.S. Akron returned to its home dock after a 3 hour and 47 min. flight on which it carried 113 naval men and civilians, the largest number of persons ever taken up in an airship. At dusk the next night the 785-ft. ship was again walked out and released for further observation of its general functioning preparatory to a series of flights to test specific qualities.

Press Cliche

NEW SOVIET TRANSPORT

The ANT-14, a 32 passenger all metal plane built by the Central Aero-Hydro Dynamic Institute which is to be flown on the Moscow-Vladivostok service.

Specifications for the construction of the Akron's hangar at Sunnyvale, Cal., indicate a structure providing accommodation for an airship even larger than the Navy's most recent addition. Contracts awarded on Oct. 1 for the structural steel work and for the covering of a building 1,138 ft. long total $1,514,981, contracts for the two projects respectively going to the Wallace Bridge and Structural Steel Company of Seattle, and to Siems-Helmers, Inc., of St. Paul. The lowest bid for the foundation and railroad track, award of which has not been made, would bring the total cost of the hangar to between $1,600,000 and $1,700,000. Construction of barracks, service buildings, and helium purification plant will consume the remainder of the $5,000,000 estimated cost of the air base.

Work is progressing at the Friedrichshafen factory on the new Zeppelin L.Z. 129. To be inflated with 7,000,000 cu. ft. of helium, it will be powered with four diesel engines probably of Maybach construction.

The much-talked-of mooring mast for airships atop the Empire State building was put to use for the first time late in September. The first contact was made by a privately-owned blimp which merely made a line fast for a few minutes and then cast off again. Later in the week, during a short contact by the Goodyear blimp, Columbia, a package of newspapers was delivered on the 103d floor balcony, while a third attempt to moor the next day was unsuccessful.

Services retire from competition

With the cancellation of the last-remaining aircraft speed event in which the Navy usually participates, withdrawal of the service from competitive flying will be complete. The Curtiss Marine Trophy Race, at present restricted entirely to naval and marine pilots and aircraft will probably be postponed indefinitely unless its opening to civilian pilots and seaplanes, now being considered by the contest committee of the National Aeronautic Association is approved.

Likewise the Army Air Corps will not hold the John L. Mitchell Trophy Race, an annual event since 1922 when it was donated by former Brig. Gen. William Mitchell in honor of his brother who was killed in action in France. Since the Army's high speed pursuit planes perform at full efficiency only at an altitude of about 7,500 ft. the race must be postponed until a sufficient number of low-altitude pursuit planes is on hand.

Crack squadrons of the Army, Navy and Marines were permitted to perform at the Four Fields Flying Show, staged in New York on Oct. 17 and 18 to help the Aviation Industries Division raise funds for the Emergency Unemployment Relief Committee.

An unparalleled air show of nation-wide scope will be staged by Army and Navy aircraft in connection with the George Washington Bicentennial celebration next year, if Representative Bloom of New York City can secure a special appropriation from Congress for that purpose. The War Department views without enthusiasm the plan for diverting a large number of planes from their normal activities and dollars from their customary budget designation.

Corporation activities

Considerable activity is evidenced by several Pacific Coast flying organizations. A mapping project of an unusual order was recently accomplished by the T. C. Ryan Aeronautical Company of San Diego, which made an aerial survey for the Department of the Interior, of Death Valley, dealing with variations in elevation of from 274 ft. below sea level to 7,000 ft. above, and temperatures of 120 to 130 deg. At the Boeing School of Aeronautics in Oakland eleven high school instructors completed a special course last summer, which prepared them to conduct classes in aeronautics in their high schools.

Among recent purchasers of the Stinson monoplane is Prince Bahadur Dossabhoy Hormasji Bhiwandiwalla, J.P., of Bombay, who came to this country to

select a plane especially suited to his needs

The entire service business of the Comet Engine Corporation, including all engine parts on hand in Madison, Wis, and in Oakland, Cal, has been sold to the Nepco Tri-City Flying Service of Wisconsin Rapids, Wis

Three plants of the General Aviation Manufacturing Corporation, subsidiary of the General Aviation Corporation in which General Motors owns a large interest have been moved to Baltimore. In the idle Curtiss-Caproni plant will be built both the military and the mail and transport planes previously turned out at Wheeling, W Va, and Hasbrouck Heights and Passaic, N J Work will be commenced shortly on twelve army observation planes and five flying boats especially adapted for the use of the U S Coast Guard

A plan to segregate the lighter than-air and heavier-than-air divisions of the Detroit Aircraft Corporation was submitted to the stockholders on Oct. 21 On their approval the Lockheed Aircraft Corporation is to take over all assets of the airplane divisions of Detroit Aircraft as well as the Lockheed plant at Burbank, Cal., while the Metal-clad Airship Corporation is to acquire the assets of the Aircraft Development Corporation, including the development work going on for the U S Navy and the patents on the riveting machinery used for the preparation of airship skin Ten shares of the present stock are to be exchanged for one of Lockheed and two of Metalclad

First of the financial reports for the first nine months of 1931 is that of the Douglas Aircraft Company, which reports net profits of $548,571 for that period, or $1 60 on each of 342,403 shares of stock outstanding Net profits for the whole year of 1930 were $2 02 per share, while 1929 earnings were only $1 19 Sales for the first ten months of the current fiscal year total $3 378,071, an increase of $117,794 over the same period of 1930

Motorless flying

Released from a tow plane at an altitude of 3,000 ft one afternoon late in September, Martin Schempp, holder of the distance record at the National Soaring Contest, soared over the downtown district of Pittsburgh for some time in his Haller-Hawk sailplane before bringing it to a landing in the Monongahela River

At the 12th Annual International Glider Contest held on the slopes of the Wasserkuppe in Germany more than 500 flights were made, five for a distance of over 60 miles each Squadrons of fifteen to eighteen gliders were seen in the air at one time, one reaching a height of 6,726 ft

A soaring meet is to be held late in October just north of Honolulu. Attempt will be made to better an unofficial record made there on July 26 by Lieut. J C. Crain of the U S. Army, who soared for 16 hours 45 min. in a sailplane of his own design

Only recently placed on the commercial market, the autogiro has already entered the field of private flying Of the first group of machines completed by the Kellett Company, three went to private pilots, residents of such diverse localities as New York, San Francisco, and Haverford

The Buhl Aircraft Company of Detroit has commenced work on a two-place open cockpit pusher model which is a new departure in autogiro design offering greater comfort for pilot and passenger, increased visibility and relief from the noise and slipstream of the propeller, as well as saving in weight Inspection by Mr. Cierva, inventor of the autogiro, who will visit this country shortly, is anticipated In the meantime Cierva has been active in England on experiments of his own, which include an autogiro with no wires of any sort on the rotor

During the National Air Races Maj Thomas G Lanphier (president of the Bird Aircraft Corporation) challenged an autogiro to a contest with a plane of equal horsepower, in the essential elements of safe flying No public response came from the autogiro people

Aviation insurance looks up

After long negotiation with the French Air Minister and the National Aeronautics Federation, the Caisse Nationale d'Assurances has subscribed to an agreement which sets a precedent important to the aviation industry. The underwriters represented by it will regard the risks of air travel as ordinary transport risks, whether the insured is traveling as passenger or pilot, with the result that premiums for life insurance will be no higher for the air traveler than for the person using rail or steamer transportation Most American life insurance companies reached this decision some time ago in regard to passengers, but by no means for the pilot

An innovation in the aeronautical industry is the group life insurance policy covering 1,500 of its employees which the Aviation Corporation of Delaware has contracted with the Aetna Life Insurance Company of Hartford. The cost of the insurance, over $3,600 000 is shared by the corporation and the employees, to whom it is available complete with total and permanent disability benefits, in amounts ranging from $2,000 to $10,000 depending on their monthly earnings

Legal decisions

The material immediately following, together with references to legal and legislative matters elsewhere in the news pages, is based largely upon the Aviation Law Service prepared by the Commerce Clearing House, Inc AVIATION is licensed to make use of this service and is able to give its readers the benefits of the work of an organization specially trained and equipped to insure the complete collection of pertinent material on current legal developments

Another decision supporting the validity of taxes levied by the state on gasoline used in air transportation was handed down by three judges of the Federal District Court for the Eastern District of South Carolina In a case brought against the State of Wyoming by an interstate transport line several months ago the ruling of the U S District Court was that the imposition of the tax was valid because there was no discrimination made against the company in levying it and the tax receipts were used to provide airport and airway facilities enjoyed by the transport operator The basis of the claims made by the Eastern Air Transport was that the gasoline purchased by it was used in interstate commerce and therefore untaxable under the commerce clause of the United States Constitution Three judges of the South Carolina District court handed down the decision that since the gasoline was subject to tax by the state at the time of leaving the hands of the oil company and did not acquire an interstate character until it was being consumed by the plane, the tax is valid and not in violation of the Constitution

Mono Aircraft, Inc, of Moline, Ill., is in the midst of an argument with the Chicago, Rock Island and Pacific Railway on the subject of carload rates on shipments of crated airplanes It has appealed to the Interstate Commerce Commission for a more reasonable rate than the $4 95 per 100 lb on a minimum of 10,000 lb charged for a shipment of airplanes from Moline to Los Angeles.

Travel by airplane on official business has been sanctioned by the government under certain conditions Controller-General McCarl, Treasury watch-dog, has held that planes may be used if the cost of such transportation does not exceed the cost of railroad fare plus Pullman fare, plus $6 per day for the time thus saved. Travel by airplane in other cases is confined to "emergency" situations, carefully limited as to their nature.

Stick control patent again

Reported discovery of fresh evidence is responsible for the reopening of a claim of patent infringement first brought against the U S Government in 1924 Robert Esnault-Pelterie, a pioneer French airplane designer, asks $2,500 000 damages for alleged infringement of his patent of the stick control system used in almost all modern planes More important than the sum involved in this suit is the fact that its success would enable Mr. Esnault-Pelterie to seek huge damages from individual manufacturers

The recent meeting of the American Bar Association was considerably enlivened by a discussion between a representative of the National Association of Real Estate Boards and the committee on aeronautic law over the question of the existence of property in air. The insistence of the aeronautics committee on the necessity of unrestricted use of air space for the development of air transportation (see AVIATION, October, 1931, page 569) was hotly denounced as an invasion of legitimate property rights by the association's real estate counsel The chairman of the meeting assured him that no actual legislation would be pressed for adoption before the next meeting of the association, to which it would be submitted

ANOTHER FLYING WING

The experimental machine flown at about 32 m.p.h with a 30-hp engine over Tempelhof aerodrome recently. The designer has a long record of work with allerons and constructed this machine on the Wasserhoppe

PETER J BRADY, chairman of the New York Mayor's committee on aviation, member of the state aviation commission, and the first commissioner of aviation in the Department of Docks in charge of Floyd Bennett Field, was killed in a crash on Staten Island Sept 20 while flying to the American Legion convention in Detroit As chairman of the Mayor's committee for aviation he had directed the development of the new municipal airport. He was an influential labor leader, organized and was president of the Federation Bank & Trust Company, and had been an aviation enthusiast for many years

LEROY MANNING, chief test pilot for the Ford Motor Company, and L. H Garriott, his mechanic, were killed Sept. 9 when the Wasp-powered tri-engined Ford bomber built for the Air Corps crashed in a power dive near the Dearborn airport Manning was a former Army pilot, at one time attached to the First Pursuit Group at Selfridge Field. He established a speed record for multi-engined craft in September, 1930, and the previous year introduced the Ford transport to Europe with an extended tour of the continent.

FREDDIE LUND, brilliant and spectacular racing and stunt pilot, conspicuous participant in the National Air Races for several years past, and test pilot for the Waco Aircraft Company, was killed on Oct 3 in a crash during a race at Lexington, Ky

SIR THOMAS STANTON, D Sc, F R S, prominent in English engineering circles and a leader in British experimental aerodynamics, died recently Superintendent of the Engineering Department of the National Physical Laboratory for many years, until his retirement about six months ago, he started his experimental work with wind tunnels in 1911

Closer cooperation with the ministries of War and Navy in the study and solution of problems concerning the air forces of the two services and better coordination of the Air Ministry with the other departments of national defense, are anticipated from the creation by the French cabinet of a Supreme Council of Air A consultative body presided over by the Air Minister, the council will have among its duties the giving of advice on questions regarding the organization of the air forces, methods of recruiting and training personnel, and provisions for maintaining and raising the technical standards of military aviation About half the members, appointed yearly, are technical consultants and have no voting power The Parisian press is pessimistic, expects little from the council in the way of action

Personnel

Richard C Marshall, of Cleveland, for the past four years vice-president and general manager of Thompson Aeronautical Corporation, has been elected president. Edwin G Thompson, former president, becomes chairman of the board of directors

R W Robbins, of Pittsburgh Aviation Corporation, is now president of Transcontinental & Western Air, Inc. J M Schoonmaker, Jr, president of General Aviation Corporation, has been appointed vice-chairman of the executive committee

Oliver A Gottschalk has been named general traffic manager for Eastern Air Transport, Inc, replacing Ralph S Westing, resigned

Lieut Comdr P V H Weems, U S N., famed air navigation expert, has been ordered to the Hydrographic Office at Washington for special duty, maintaining liaison between military and commercial aviation on navigational practices and equipment

David Visel, formerly vice-president of Curtiss Airport Corporation, has been appointed manager of the Curtiss-Steinberg Airport, East St Louis, Ill, and Karl S Day has been made manager of the Curtiss-Reynolds Airport, Chicago

Maj J S Buchanan, lately superintendent of technical development at the Royal Aircraft Establishment, Farnborough, England, has been appointed director of technical development at the British Air Ministry

Joseph W Sabin, general traffic manager of Universal division of American Airways, has been appointed assistant general traffic manager at the New York office Charles S White, Chicago traffic representative, has been named acting general traffic manager for the Universal division Capt Trevor G Williams, of Minneapolis, has been appointed assistant to Colonel Dunwoody, vice-president and general manager of Universal

Statistics of the Month

Material supplementing the statistical issue, AVIATION, March, 1931, appears regularly each month. Page numbers in the statistical issue are given.

PRODUCTION AND LICENSING
(Page 130)

THE curves of total and licensed airplanes, which in July and August showed a tendency to follow a definite upward course, have since become erratic. There has been no real increase in total planes since that time

AIR MAIL AND TRANSPORT
(Page 163)

THOUGH reports of air mail transportation are received monthly from the Post Office Department, the semi-annual summary recently released by the Department of Commerce offers the only data available on the subject of passenger operations The tabulations, begun in 1930, this year for the first time permit comparison with a similar period of another year. They show a total of 20 304,430 miles flown by airlines in this country and American-operated lines extending into foreign countries, In the first six months of 1931, an increase of 20 per cent over 1930 Despite this increase in total mileage, passenger-mileage flown in the United States in the first six months of this year is a scant 1 per cent in excess of the 1930 figure while a drop of more than 40 per cent in the volume of traffic on foreign routes brings the total 1931 passenger-mileage down to 8 per cent below the total last year About the same percentage decrease is reported in number of passengers carried.

To simplify the analysis of passenger traffic figures the individual airline operators are divided into two groups, one including only lines devoted exclusively to passenger transportation, the other listing operators handling mail as well In each group are listed all the operators carrying more than 1,000 passengers, and also the routes of each company on which more than 500,000 passenger-miles were flown Totals for each group for each year were obtained by adding the passenger figures for all the individual routes on which mail was carried and for those on which it was not In such a case as Transcontinental & Western Air, a company which operates both mail-carrying and non-mail-carrying routes, its operations were divided between the two groups and its figures included in the respective totals The totals for each of the two groups include, in addition to the listed lines, the figures for a variety of small transport operators.

The transfer of the T A T,-Maddux lines to the ranks of mail carriers is partly responsible for the reduction of the volume of exclusively-passenger lines from the 80 per cent of total domestic passenger-mileage which they controlled in 1930 to 29 per cent of the total for the first half of 1931. This decrease occurred despite the formation of four new passenger lines which accounted for almost nine and a half million passenger miles in the first six months of this year, more than 20 per cent of the domestic total

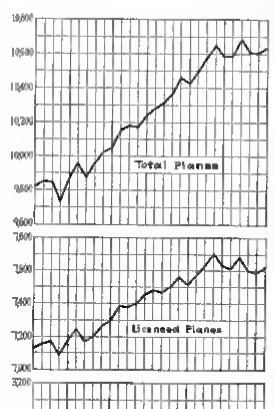
The bulk of passenger air traffic in the United States, however, now goes to combined mail and passenger operators, more than half of it being handled by the three most important of these, each an outstanding example of the process of consolidation which has been molding air transport operations during the past year United Air Lines is the only one of the three to show an increase in passenger-mileage over 1930, due to its having started the carriage of passengers on several lines previously devoted exclusively to mail and express. With American Airways and Transcontinental & Western Air combination has meant elimination of duplicating or unprofitable routes, rather than extensions and additions to previous schedules

Especially illustrative of the trend towards consolidation is the fact that ten operators, including the four new non-mail-carrying organizations, accounted for 89 per cent of the total domestic passenger-mileage In the foreign field Pan-American Airways and Pan-American-Grace handled about 90 per cent of all passenger traffic.

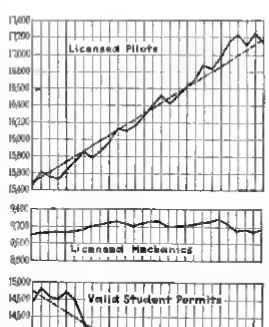
In the light of recent developments of mammoth passenger transport planes the average of passengers carried per ship on the various routes is amusing The averages vary from 6 6 passengers on the Ludington Line's Washington-New York run to 0 8 on the lines of the National Parks Airways, the average load carried by all operators being 2.3 persons In several cases, however, at least one plane devoted entirely to mail is flown at night, with a resultant distortion of the average passenger load so that in some cases the true average for the flights on which passengers are permitted might run as much as 50 per cent above the figure given

It is in the field of mail transportation that most evidence of improvement over last year is found, the amount of mail carried in the United States being more than 20 per cent greater in the first half of this year than in the first six months of 1930, while mail to and from foreign countries increased by more than a third, bringing the 1931 total 22 per cent above the level of the previous year Since the recent combinations of airlines, mail transportation is handled entirely by nine operators. All of them are well established in passenger transportation as well although a few like Eastern Air Transport, have only recently entered that field

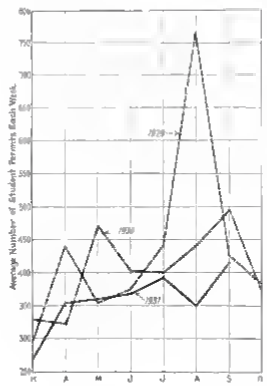
Though many of both passenger and mail operators carry a small amount of express, in most cases it is only incidental. The Ford Motor Company is an exception to this rule, 882,559 lb of express being carried by its private line in the first half of this year and 1 117,-834 lb in the same period of 1930 Express operations of the Ludington Line, next in order, totaled 102,600 lb In-auguration of new services to Latin America have made a striking change in express traffic on the foreign lines, which in the first six months of last year carried barely a ton and a half of express, as against 169 887 lb in the early months of the current year



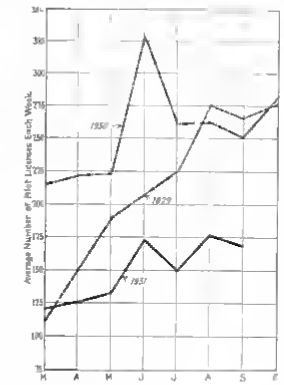
Valid airplane licenses and identifications



Valid pilot licenses, student permits in force and valid mechanics licenses



Student permits newly issued month by month



New pilots licensed, month by month

Scheduled Air Transport Operations—January to June 1930 and 1931

	Miles flown		Passengers carried		Passenger-miles flown		Average number of passengers per plane		Mail (pounds)		Express (pounds)	
	1931	1930	1931	1930	1931	1930	1931	1930	1931	1930	1931	1930
Air Ferries, Ltd	54,202	84,596	18,506	56 510	12 142	219 068	2 1	2 6	0	0	55 430	0
Bowen Air Lines	531 504		5 627		1 257 795		2 4		0		0	
Fort Worth Tulsa	616 784		6 506		680 035		2 4		0		0	
Braniff Airways	1 150 950		2 586		1 055 500		6 9		0		0	
Tulsa-Chicago	120,970		1 151		768 040		0 0		0		0	
Century Air Lines	515,501		14 747		2 193 565		3 0		0		0	
St. Louis-Chicago	166 786		6,374		688 648		4 0		0		0	
Chicago-Toledo	16,656		1,438		201 007		1 3		0		0	
Curtiss Air Transport	44 095	26,270	6 525	4,159	102,135	79 095	2 5	5 0	0	0	12,551	4,281
Kohler Aviation Corporation	106 752	81 440	1,755	755	195 360	86 825	1 9	1 1	0	0	14 651	40 255
Mid-Continent Air Express Corporation	575,897	227 478	1,658	1,054	566,668	201,567	1 0	0 9	0	0	211	0
N Y, Philadelphia & Washington Airways	758 910		50 189		4 940 579		6 5		0		102,600	
Washington New York	744 818		50 198		4 900 599		6 6		0		100,000	
Pittsburgh Airways	246 458	44 450	2,250	568	629 500	105 330	2 6	2 4	0	0	0	0
Pittsburgh New York	208 858	44 456	2014	568	604 400	105 330	2 9	2 4	0	0	0	0
Rapid Air Transport	121 100	23 896	1,300	595	286,200	23,896	2 2	1 0	0	0	99	0
Wedell Williams Air Service	204 642	122 320	1,218	671	242,191	149 180	3 6	1 2	0	0	0	05
Total passenger lines	4,457,927	6,014 699	92,236	159 200	14 470 802	33,504,230†	3 2	5 5	0	0	197 937	76 455
American Airways	3,205 476	3 165,872	19,019	54 627	5 032,780	9 021 389	1 6	2 9	625 965	461 528	7 451	5 165
New York-Boston	306 892	361 590	8 158	8,708	1,478 112	1 823 400	5 8	4 9	85 697	69,675	4 114	8 166
Atlanta-Los Angeles	144 981		3 098		1,005,670		6 7		103 351		2 986	
St Louis-Chicago	865 728	1 803 861	8,170	4,135	616 111	1 088 018	0 7	0 7	33 930	27 616	133	798
Eastern Air Transport	1 642,634	736 718	11 101	0	2,944 558	0	1 8	0 0	470 234	506,161	0	0
National Parks Airways	262 144	252 307	1 071	909	205 005	172 991	0 8	0 6	20 359	20 606	7	42
Northwest Airways	662,747	479,045	5,561	2,450	1 741 975	766 440	2 6	1 6	136 304	107 524	0	0
Chicago-St Paul (via Rochester)	186 611	135 500	1 116	1,043	184,869	481,065	6 0	3 4	*	*	0	0
Chicago-St Paul (via Milwaukee)	662 681	874,286	1 041	864	676,086	807,770	0 8	1 1	*	*	0	0
Pennsylvania Airlines	162,825		1 025		529 242		2 0		53 695		184	
Transcontinental Airlines Corporation	571 561	297 889	6 256	2,150	998,994	211 698	1 7	0 7	83 315	87 785	6,335	1 014
Chicago-Detroit	161 648		2 424		296 076		1 8				2,163	
Transcontinental & Western Air	2,282,085	3,084 918	17 506	26 541	8 815,400	13 012 373	5 5	5 3	576,772	459 615	20 541	18,427
New York-Los Angeles	1,403 566		10,864		6 372 940	10 016 698	4 6		186 660		6,958	
Los Angeles-San Francisco	206,308	641,300	2 868		1,332 881	4,161,1776	0 6	7 6	0	0	80,360	1,000
United Air Lines	4,909,673	5 611,055	19 074	3,604	8 206,938	1457 248	1 7	0 4	2,571 852	2,216 767	38,519	56 617
San Francisco-Chicago	1,264 468	1,441 018	8 066	1 465	6,057,655	584 116	2 8	0 6	681 183	695,486	3,476	7,668
Chicago-New York	61,825	686 417	6,064	0	2,768,486	0	3 1	0 0	836,408	609 143	16,140	64,048
Dallas-Chicago	864 858	885,023	3 191	0	1 140 531	0	1 7	0 0	858 970	804 445	1,948	2 403
San Diego-Seattle	816 136	867 990	3 136	1 901	1,270,068	708 189	2 1	0 9	178,492	108,693	1,048	2 837
United States Airways	188 464	270 200	1 196	1 640	479 720	856,300	2 8	3 1	2,578	0	0	0
Total passenger and mail lines	15 671 241	8,521,216	77 560	26 756	26,385 056	6 815,572	1 9	0 8	4 332,714	3,571 956	49 485	48,149
Miscellaneous	921 520	2,085 565	8 766	69,655	1,041 849	11,084 888	1 1	5 3	0	0	896 056	1,136 912
Total domestic routes	18,129,168	14 595,915	169 816	185,956	40 855 654	40 519 602	2 3	2 7	4 552,714	3 571,956	1 121,976	1 242,439
Total foreign routes	2,175,262	2,366,815	23,855	22,401	6,646,247	11 290 147	3 0	4 9	256,995	189 420	169 887	3,019
Grand total	20 304,430	16,962,728	195 652	208,557	47 501,901	51,809 749	2 3	3 0	4,589,707	5 761 376	1 299,863	1 245,427

*Included in above total. †Includes T. A. T.-Maddux, which in 1930 carried passengers only. ‡ This route was covered in 1930 by Western Air Express operations between El Paso and Los Angeles, on which 1,004,221 passenger miles were flown for the period covered by this report, and which suspended operations when American Airways took over the company in the fall of 1930 § Includes all operations by both T A T and Western Air along routes which have since been combined. ‖ This figure includes operations of the line previously known as West Coast Air Express, which merged with Pacific Air Transport when the general reorganization of air lines occurred and which flew 1 040 752 passenger-miles on the San Francisco-Seattle route in the first six months of 1930 ¶ In the total of two lines operated between Los Angeles and San Francisco, one by T A T.-Maddux and one by Western Air Express.

Development of military aircraft design

By Capt. Hans Ritter

Late of the German General Staff (Air Force Section)

Capt. Hans Ritter, whose first article in AVIATION appears herewith, has an international reputation as a student of military affairs. His "Criticism of the World War" has been the subject of almost extravagant praise, both in Europe and in America. His volume on "War in the Air" has been translated into English for reproduction in the Royal Air Force Quarterly. Pursuing our regular policy of offering the best possible discussions of the design of military equipment as affected by tactical and strategical developments, we have secured from Captain Ritter two articles, of which this is the first. The second will be concerned principally with the development of fighting planes, as this one is with bombers. ¶Some of Captain Ritter's observations and criticisms will sound very strange to American readers. His views are of course based principally upon European development, from 1915 down to date. In military affairs it is of peculiar importance to know upon what basic theory other nations are building, and what line their military plans follow. Captain Ritter writes with authority for a substantial school of European opinion. What he has to say, both about the design of aircraft and about their possible use in war, deserves the most careful study.

THE problem of the future development of military aircraft construction may be considered from a number of standpoints. One obvious method is to accept as a starting-point the course and rate of such development in the past. It is possible then to extend the curve of development into the future, in order to arrive at the presumptive stage of aircraft development at any chosen period. This, naturally, can only apply when the assumption is made that the rate and the point of aim of development will remain constant in the future. Obviously this line of thought approaches reality, but is liable to involve the assumption that future development will also be prompted by the same motives as have directed it hitherto. Whether this can be considered as an incontrovertible fact, or whether, on the other hand, a change in these motives must be foreseen, or even hoped for, is of course a question for study.

In attempting to arrive at a solution of the problem, those factors which have guided and determined development up to the present day cannot be accepted as sure to determine it in the future. It is necessary first of all to review the events of the past and to examine the present state of the art and the ways and means by which it was attained, to see how it was that an air arm has been created and an air strategy evolved. A beginning must be made by deciding on the nature and aims of this phase of warfare.

It is necessary to differentiate in principle between two standpoints on this matter. The first, or French view, holds that every war will always, and under all circumstances, be primarily decided by land power or sea power, and that the air arm in itself is incapable of carrying out enterprises of decisive effect. Warfare must, then, be carried on in as concentrated a manner as possible, and we must logically regard the indirect intensification of the striking power of the land or sea forces as the first and foremost duty of the air arm. The field of activity of the air arm is, therefore, the theatre of war on the ground or on the sea. Air undertakings outside this theatre are "side shows" and only in a few individual cases justifiable. The aim of aircraft development, therefore, must be the increasing of those characteristics and performances which are of the greatest importance for the employment of the air arm as an auxiliary weapon of the land or sea force.

Concentrated action

As is well known, this standpoint is directly opposed by another, which, by reason of its faith in the absolute efficiency of air attack against ground objectives, brings its upholders to the conclusion that action must be taken in as concentrated a manner as possible against the very heart of the enemy power. Now this heart always has been, and still is, the belligerent nation itself. Its will and its material resources for the carrying on of hostilities must be broken. Of these two factors the most important is the will—the morale—, as once this is destroyed the enemy will have no further need of his material resources. Sea and land forces are capable only of exercising pressure of a very limited kind on the morale of an enemy people, and such pressure is entirely dependent upon individual opportunities and the conditions which they present. Before sea and land forces can make their influence directly felt, they must always first of all break down the opposing wall—the enemy sea and land forces.

In the case of the air arm however, no such dividing wall exists. An air offensive admits of no "trench warfare." From the very outset of hostilities, direct attacks can be carried out on the heart of the enemy nation. To what extent the will of the enemy population can be broken down by means of such attacks depends on the efficiency with which they are carried through and on the social and economic characteristics of the enemy country. In the case of all nations who may now be regarded as first-class powers these social and economic characteristics are of a nature which renders the population extremely sensitive to attack from the air. The law of "concentrated action in warfare" logically demands, therefore, the independent employment of air power against objectives behind the sheltering wall of the enemy's land and sea forces. Furthermore in the interests of a concentrated conduct of air war all material and means which in any way whatsoever can be made available must be placed at the disposal of the air arm. The assignment of aviation to the task of directly supporting the land and sea forces must be reduced to a minimum. The Italian General Douhet goes so far as to say that they should be cut to zero.

Compromise impossible

The two standpoints, described above, are diametrically opposed to each other. No compromise exists. One or the other of these fundamental principles must be adopted as the basis of the critique, and, as the author's opinion upholds the second of the alternatives presented, this will serve as the basis for his further remarks. [The first of the two views outlined by the author is of course that officially held by most of those in official authority in the Army and Navy in the United States and Great Britain. The second is the view made famous by General Mitchell, and widely upheld both by civilian writers on war and by officers of the air services, particularly the Army Air Corps.—Ed.]

We can, then, confine our further remarks to the technical development of such types of aircraft as are of importance in the tactics of air operations directed against the enemy nation itself. They are the bomber, as carrier of the attack, and the fighter, as bearer of the brunt of the counter operations brought about by the attacks. The essential military characteristics of the bomber and fighter types as required in the light of their special tasks, are:

Bombing aircraft

1 The bomb load for various ranges of action, expressed in percentages of the total flying weight of the aircraft.

2 Such properties as are of importance for the overcoming of enemy defence from the ground. For instance:

a The degree of silence attained.

b The flying height, which must be considered in relation, on the one hand, to the normal effective range of the enemy anti-aircraft guns and, on the other hand, to the size of the target presented by the bomber and to its facility of maneuver.

3 Such properties as are of importance for the overcoming of enemy counter-measures in the air. These are:

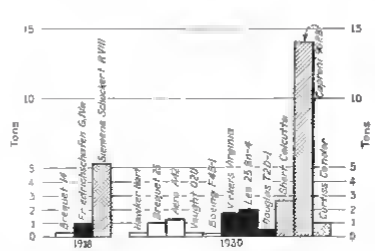


Fig. 1: Weight of bomb loads (in tons) designed to be carried over a range of 500 miles.

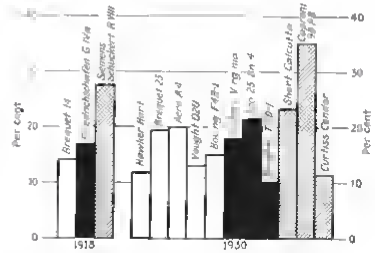


Fig. 2: Bomb loads (in per cent of gross weight of plane) designed to carry over a range of 500 miles.

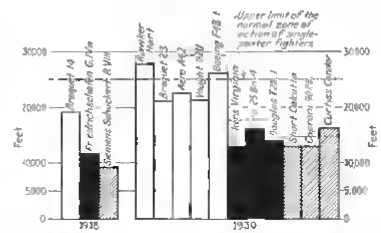


Fig. 3: Comparison of service ceilings (in feet) of 1918 and 1930 bombers. The broken lines over the 1930 group denote the ceilings which should have been attained in order to correspond with the 50 per cent increase in range of anti-aircraft guns since 1918.

a Again, silence.

b Again, flying height. The height of the service ceiling is not of great importance in so far as it relates to the time taken for enemy fighter aircraft to attain the necessary attacking height, for these times of climb are in themselves so small that a minute or two more or less is of no practical moment except in a few special cases (for example, the defence of London). [Or of the Panama Canal—Ed.] The service ceiling only becomes a really decisive factor when it enables combat to be carried on at such a height that the fighting efficiency of the pilot of a small open fighter aircraft becomes seriously impaired as a result of the physical or psychological strain that is thrown upon him. Such a pilot cannot be afforded anything like adequate protection against cold and low air pressure at high altitudes. Provision of normal breathing air, relief in his duties by their sub division among a crew of several people, or their transfer to automatic control appliances (such as may be afforded in the case of a large machine) do not apply in his case. From this point of view, then, the lower limit for the service ceiling of a day bomber should be in the neighborhood of 25,000 ft., taking that as the maximum altitude at which a fighter is effective in military operations.

c Speed of flight, insofar as it renders the task of the enemy fighter aircraft in forcing an engagement more difficult.

d Strength and efficiency of armament.

e In connection with (*b*), the provision of appliances assuring the maintenance of the physical and psychological efficiency of the crew on long flights at high altitudes and under all weather conditions.

f Apparatus influencing the accuracy of bomb-dropping.

Fighter aircraft

1. Such qualities as render it possible to force an enemy to fight in the air. Among these must be considered:

a Attainment of any necessary altitude in the shortest possible space of time.

b High speed at every altitude and, above all, at high altitudes.

c Good field of vision in the air.

d Means of communication with ground signal stations and with other aircraft.

2. Such qualities as are of a decisive nature in aerial combat, such as:

a Appliances assuring the maintenance of the physical and psychological efficiency of the crew on long flights at high altitudes.

b Superior maneuverability, thus ensuring choice of the most favorable position against the enemy in all three dimensions. This is usually governed by the amount of reserve power remaining available at fighting altitudes. The relation of weight to horsepower is, therefore, a means of comparison.

c Armaments of high offensive quality (range, accuracy, and destructive effect of the individual projectiles).

It is now possible to investigate the development achieved during the period 1918-1930 in the two types of aircraft which are of paramount importance in independent missions in aerial warfare, and, from this as a basis, to determine how far the progress in the development of such types corresponds with the demands likely to be made on them, and whether or not such development should be carried on in future along the same lines as hitherto.

Bombing loads

The amount of bomb load which can be carried for a given distance is the principal standard of importance in judging the efficiency of the bomber as a weapon for employment in independent air operations. The tasks allotted to this type of machine can only be carried out successfully if a really great destructive effect can be achieved. In the "Revue des Forces Aériennes" of October, 1930, the French Colonel Guillemeney makes a critical review of the efforts of the French Air Service in the years 1917 and 1918 to prevent the use of the smelting works in the well-known Briey Basin. The number of bomber squadrons employed in carrying out attacks on the Briey Basin during the years 1917 and 1918 varied between zero and eighteen and the quantity of bombs dropped each month between 3.6 and 103 tons. The heaviest bomb employed, however, weighed only 110 lb. From June 1, 1917, until the armistice 780 tons of bombs were dropped on the Briey Basin, an average of 46 tons per month. What was the result of this expenditure of effort? Colonel Guillemeney answers the question quite candidly: "We did not possess the necessary instrument, and, indisputably, this is the sole reason for our inability to bomb effectively either factories or railway stations. All questions in the sphere of aerial operations are governed by technical possibility . . . *The result of our bombing attacks on the factories and blast furnaces, viewed from the standpoint of actual destruction, was nil.*"

A particularly searching analysis into the efficiency of their own bombing attacks was carried out by the French after the War in respect of the railway station at Thionville, which was always regarded as one of the principal objectives. The points of impact of a total of 1,372 bombs dropped on Thionville were to a great extent successfully identified. All these bombs, without exception, were aimed at the railway sidings and equipment of this town. Of the total of 1,372 bombs only 140 actually hit the station or sidings, and of these 23 were "duds." Thus, including "duds," only 10 per cent. and, deducting these, only 9.5 per cent. of the total number of bombs dropped hit their objective. This meager result leads the French expert to sum up as follows:

"No matter what the nature of the bombing objective may be (usually it will consist of targets at long distances), important results can be achieved only with the greatest possible total weight of bombs.

"The only suitable instrument for the carrying out of bombing attacks in which destruction is the principal object, is, therefore, the large airplane with large radius of action. By large airplane I mean an aircraft of about the same size as the Caproni 90 P.B" [26,000-lb. bomb load.—Ed.] [Although American opinion, especially in the Navy, does not at present concur with the author's views and those of Colonel Guillemeney about the desirability of using bombing machines of enormous size their conclusions are to some extent supported by American experience on the need for bombs of very large unit weight. In the bombing of armored ships or of solid structures such as the concrete bridge attacked by the Army Air Corps four years ago, it has developed that a bomb of at least 1,000 and preferably of 2,000 lb. weight is necessary to give destructive effect. Smaller projectiles are likely to splatter almost harmlessly on such objectives.—Ed.]

Size of bombers

The review in Figs. 1 and 2, where the bombers are divided into light, medium, and heavy classes for comparison of the war-time and present-day products, shows the progress in this respect which has been achieved in the technique of aircraft construction since 1918. For 1918, the light day bomber Breguet 14, the medium bomber Friedrichshafen G. IVa, and the giant Siemens-Schuckert R. VIII are used as typical examples. For 1930, the day bombers Breguet 23, Hawker Hart and Aero A42, the medium night bombers Vickers Virginia and Liore et Olivier Leo 25 Bn-4, and further, the huge Caproni 90 P.B, and the flying boat Short Calcutta. [Several American types have been added for comparison.—Ed.]

Only a solitary model—the Caproni 90 P.B.—represents a real advance in size. The employment of large flying boats in this branch of air warfare suffers from the disadvantage of their having too much dead-weight to carry, owing to the demands made upon them in respect to seaworthiness, thus leading to a great reduction of the proportion of bomb load to total flying weight. Most of the landplane bombers available today do not possess the absolute bomb-carrying capacity essential for the carrying out of independent air operations. These machines can only be considered as modern when judged according to the French standpoint previously described. That is to say, they are more or less general purpose types.

Turn now to *2a* and *3a* under "bombing aircraft" in the previous text. One is forced to the conclusion that no practical progress has been made since 1918 in respect of reduction in noise from engines and airscrews. Technical science will have to explore new roads for the realization of these aims, but it has not yet been done. A favorable groundwork exists in this respect, in that engines with airscrew reduction gears are being employed more and more. By this means the noise from the airscrews is greatly reduced, and there remains to be achieved only the silencing of the exhaust and the gears themselves.

Altitude and ground fire

With regard to *2b*, altitude, as the measure of immunity from anti-aircraft gun fire, may be judged from two standpoints. First, we must take the effective height of such fire, and we may assume that it has been increased by 50 per cent. since 1918—a figure which is certainly not an exaggeration. If, then the ceiling of bombing aircraft has also been increased by 50 per cent. since 1918, everything remains approximately as before. If the increase in service ceiling is greater, we can record progress, but if less, we must consider it a retrograde step. On this basis Fig. 3 has been drawn. In it the ceilings attained in 1918 by those aircraft which have been chosen for purposes of comparison are shown, together with the ceilings which the corresponding types of machines chosen for 1930 should possess if the 50 per cent increase could be recorded, and finally, the actual ceilings attained by these last mentioned aircraft.

The estimated upper limit of the sphere of action of normal fighting machines, assumed to be 25,000 ft. is also shown in Fig. 3. This diagram reveals the fact that practically none of the larger bombers, i.e., those types which are of the greatest importance in independent air operations, satisfy the demands made upon them or have the ability to pass above the zone where fighter attack will be most effective.

3c. Comparison is here made between the flying speed of bombing aircraft of 1918 and 1930 and the flying speed of fighter aircraft of the same periods. The Breguet 14, Siemens Schuckert R. VIII and the Spad S. 29 (fighter) have been chosen as the types for comparative purposes for 1918. The Hawker Hart, the Caproni 90 P.B, and the Fokker D. XVI (fighter), representing European types, and the Douglas T2D-1 and Curtiss Condor bombers and the Boeing fighters representing American types, respectively, for 1930. The comparison has been made taking an altitude of 10,000 ft. as the basis for 1918, and 13,000 or 20,000 ft. as a basis for 1930. The results are shown in the tabulation presented above which depicts the flying speeds of the bombers expressed in percentages of the speeds of the fighters corresponding to their respective periods. The bombers in general appear to be slightly, but only slightly, faster relative to the fighters than in 1918.

Comparison of flying speeds of 1918 and 1930 bombers in percentages of speeds of fighters

1918	
Breguet 14 compared with Spad 320 at 16 000 ft.	78.0
Siemens Schuckert R. VIII compared with Spad 320 at 10 000 ft.	66.5
1930	
Hawker Hart compared with Fokker DXVI at 20 000 ft.	69.0
Caproni 90 P.B compared with Fokker DXVI at 13 000 ft.	71.0
Douglas T2D-1 compared with Boeing P.26.1 at 6 000 ft.	76.6
Curtiss Condor compared with Boeing P.12.C at 7 000 ft.	68.6
Vought 92U compared with Boeing P.6.1 at 6 000 ft.	86.6

3d. The armament of bomber aircraft must be regarded principally from the defensive standpoint. It is not necessary to go into details here, but we can record progress since 1918 in regard to the area covered by the field of fire. Unfortunately, the same cannot be said regarding the accuracy of this defensive fire. The method of mounting armament has remained much the same as in 1918, whilst on the other hand speeds have increased very considerably. Such a state of affairs certainly gives rise to misgivings. The necessity for the production of devices for the mechanical handling of flexible guns cannot be denied.

3e. It may be recorded here that aircraft of the size of the Caproni 90 P.B provide all that is technically necessary to compete effectively with the conditions prevailing in high altitudes. The provision of a sealed and heated cabin in the fuselage of such a large machine would occasion no difficulty. It is not known, however, that such a development has anywhere ever been put into practice. Only a tentative effort can be recorded in the latest French reconnaissance machines such as the Breguet 27, where some attempt at least has been made to protect the crew from the wind. The objection is often raised against the proposal to build a sealed cabin in aircraft intended for operations at high altitudes that damage to such a cabin during an aerial combat would render it useless. This objection hardly holds good. In any case, such a sealed cabin would have fulfilled its object quite satisfactorily if only it preserved the efficiency of the crew by protecting it from the physical strain of high altitude flying up to the moment of commencing a combat.

3f. The devices upon which the accuracy of bomb-dropping depends are the sighting apparatus and the actual launching apparatus. Much progress has undoubtedly been made since 1918. Unfortunately, the value of this progress is rendered somewhat illusory by reason of the fact that methods of delivering the bomb to its destination have remained unaltered and it is in this means of delivering the projectile that the greatest source of error in bomb dropping lies. As long as ways and means are not discovered for increasing very considerably the velocity of the bomb it will not be possible to achieve greater accuracy. The best and most exact sighting devices cannot be utilized to their fullest extent under such conditions. An increase in velocity might be achieved in various ways—either by the fitting of a set of rockets or by the development of a dropping apparatus somewhat on the lines of a torpedo-tube to impart to the bomb a certain initial velocity.

Primitive methods

In view of the present-day condition of bombing, the depressing statement can only be made that we are still bound fast by primitive ideas. There is an anecdote which always recurs to the author's mind when considering present-day methods of bombing. During the battle of Nisib, Field Marshal von Moltke, instructor to the old Imperial Ottoman Army, observed a Turkish soldier whose nerves were obviously suffering from the effect of the noise caused by his rifle and who fired in the general direction of the enemy, but, with his head turned away. The Marshal asked this hero, in an astonished manner, why he made no efforts to aim and obtained the reply: "Inshallah wurdn" "If it be the will of Allah I will hit the target." Our bombers of today must prevail largely upon the same factor as did that valiant champion of Islam.

The autogiro, as I see it

By Harold F. Pitcairn

Harold F. Pitcairn

WHEN fourteen years old, with lots of enthusiasm but without much to base it upon, I made a wager that within ten years there would be as many airplanes as automobiles. As the ten years slipped away it became increasingly evident that this enthusiasm was misplaced. Nevertheless, my fascination for aviation was not abated and I studied the subject on every opportunity. It became obvious to me the more I studied, that the airplane could never become a flying machine of real utility for the private owner, and that it would have great handicaps to overcome in the field of transportation. Therefore, I was constantly on the lookout for some new principle of flight, and entered the airplane business with some reluctance as it had been my hope that something better than airplanes could be built.

Just before this, Agnew E. Larsen, who is now chief engineer for the Autogiro Company of America, became associated with me and collected all the published material he could find on helicopters. These articles brought out the fact that as much weight per horsepower could be lifted by a helicopter, at least near the ground, as could be lifted by an airplane, but that helicopters had never promised much commercially in view of their great instability and difficulty of control. In view of this, it was surprising to find extremely good inherent stability on a toy tin lifting propeller with which we experimented. Finally we reached the conclusion, rightly or wrongly, that the reason this little propeller was stable was because it was single, whereas all the helicopters described in the articles collected had two or more lifting propellers.

Therefore, our attention was immediately attracted to the autogiro when a discussion of it appeared in the December, 1924, Bulletin of the American Society of Mechanical Engineers in the course of an article on the "Development of Helicopters" by Professor Klemin. Later in the year, we went to Europe to study aircraft construction and during this trip went to Madrid to see the autogiro. It was not in flying condition but Mr. Cierva showed us some moving pictures of it in flight. Interesting as the fact was that the autogiro flew, we were not impressed because the distance required for its take off was considerably more than that required for an airplane. This was due to the taxiing necessary to bring the rotor up to the proper rotational speed before take-off.

Upon our return to this country, Pitcairn Aviation was organized, airplane construction was started and a small flying service established under the direction of James G. Ray, who is now a vice-president of the Autogiro Company of America.

During this period, experiments with helicopter models were conducted with quite a number of very successful flights, but it became evident that the problems involved in creating a practical full size helicopter were staggering.

First impressions

In the summer of 1928 Mrs. Pitcairn and I were in England on a short pleasure trip, and before leaving London I thought it would be interesting to see the autogiro fly, although I had little hope that anything would come of it.

Fortunately, an autogiro with dual control was available for demonstration. It impressed me most unfavorably on the first part of the flight. It was necessary to taxi around the field for a long time before taking off and I confess that I was very nervous about going up in such a "freak" machine. For the first five minutes I was nearly petrified with fear and looked fixedly at the rotor tachometer thinking "if that rotor stops turning we will fall like a stone." Presently my courage returned and I started to look around. Later on, I asked the pilot to give me the controls, and found that the machine was unstable longitudinally, laterally and directionally. My opinion of the autogiro went down a few pegs more.

The relation of the rotational direction of the propeller and rotor was wrong on this machine and so it was necessary for the pilot to move a wheel to alter the lateral tilt of the rotor when vertical descent was desired. This seemed to me to remove the machine still further from being fool-proof. The autogiro appeared to be inferior to the airplane in every respect and I was all for landing immediately, extending thanks for the demonstration and going my way.

However, Mr. Rawson, the pilot, made some vertical descents. These impressed me as being remarkable. When we landed, the machine did not roll more than the length of its fuselage. This was certainly something to think about. There was no one at the field who could answer my questions which were numerous, so I asked Mr. Cierva to dinner, and to my surprise he answered every question to my complete satisfaction. So long as the autogiro was in the air, nothing could stop the rotor. Taxiing before take off could be eliminated by a rotor self-starter and the take off run would be shorter and angle of climb steeper than the airplane. There would be no danger in stalling if the engine stopped as the machine could then gently settle. Longitudinal, lateral and directional stability could be built into an autogiro as well as into an airplane. If the engine turned in the right direction in relation to the rotor, the pilot would have no extra lever to move when wishing to descend vertically.

We discussed the autogiro for about four hours and I was much impressed with Mr. Cierva's sincerity and ability, as well as the possibility of developing the autogiro. I told him that I wanted him to build a machine for me but before definitely placing the order wanted to discuss the matter with my associates, since it was such a radical departure from the airplane and it seemed to me that there was much to be done to perfect it.

Learning to fly the 'giro

Somewhat to my surprise, my associates approved the purchase of the machine and when it was completed I returned to Southampton, England, to learn more from Mr. Cierva about the autogiro and to learn how to fly it.

By far the most difficult thing I had to learn in handling the machine was to bring the rotor up to speed before taking off. It was much more difficult then to do this without the starter than it is now, because of the improvement in rotor blades. After bringing the autogiro to this country it was flown many hours under many conditions and thus first machine was recently flown to Washington and landed right at the front door of the Smithsonian Institution where it is on permanent display. Mr. Cierva had insisted that the angle of climb of this machine was better than the Mailwing so we ran some tests to determine the relative ability of the autogiro and Mailwing to clear obstacles. The autogiro and Mailwing each had a Wright J-5 engine and both machines were given the same gross load for the purposes of the test. Since there was no self-starter on this autogiro it was necessary to land and, after coming to a stop but before the rotor slowed down, to open the throttle, take off and climb it at its best angle. The Mailwing would then be brought up to the spot where the autogiro started to roll and would be taken off and climbed at its best angle. Approximately 1,800 ft. from this point were stationed two men placed 1,000 ft. apart with protractor sights which were moved in the vertical plane only, and from these instruments the altitude of each machine was accurately determined as it crossed the line.

The test was repeated a number of times and to the surprise of all of us, the obstacle that the autogiro could clear 1,800 ft. away was about 20 per cent higher than could be cleared by the Mailwing. It was hard to believe this because the rate of climb of the Mailwing was much better which gave the optical illusion that its angle of climb was also better. A machine which gains altitude rapidly gives the impression of having a sharper angle of climb than it really has. The shorter the distance between the starting point and obstacle the more favorable the test would be to the autogiro.

Repeated experimentation proved that the autogiro would not tail spin and that the bottom would not fall out even when it was brought to a standstill in the air. This seemed to all of us to be extremely important from a safety point of view. We were also convinced that there were many more opportunities for improving the performance of the autogiro than existed with the airplane and that the performance of the autogiro would in time equal that of the airplane without losing any of its own characteristics. With improved performance and a good self-starter we saw no reason why it could not be developed into a real utility machine for both the private owner and for transportation work.

The Pitcairn-Cierva Autogiro Company (now Autogiro Company of America) was therefore formed and took over the patent rights for this country. The work that the new company would have to do in developing the autogiro in America in co-operation with the great undertaking that was going on in England under Mr. Cierva's direction was so large that it was believed that success required concentrating our efforts almost entirely upon its development. Therefore, the difficult decision was made to sell the airline which was prospering at the time. On the surface, it looked as though we were going back on what we had started to do, but the disposal of the airline placed us in the position of returning to our original idea — the development of a practical utility aircraft.

The problems involved had many complexities but they did not seem impossible in view of the assistance we knew we would receive from the experience and genius of Mr. Cierva and because of the experience of our own personnel.

License policy adopted

The autogiro was the development of many years of concentrated work including both engineering and continuous flight testing. Without the benefit of the work done and being continued by Mr. Cierva it would have been a staggering task to have advantageously tackled the autogiro development with the purpose of adding to it the benefit of our extensive experience in construction and operation of airplanes.

It was felt that the manufacture of the autogiro was too big a problem to be confined to one interest and therefore the decision was early made for the Autogiro Company not to go into manufacture, but to license others to do so, and give them the benefit of the knowledge and experience gained in the development of the machine. It was not clear how long it would take to interest licensees and it was also felt that success required at least one successful manufacturer from the start. Therefore, Pitcairn Aircraft was granted a license to manufacture autogiros.

Since that time, Kellett Aircraft of Philadelphia and Buhl Aircraft of Detroit have also become licensees and there are others who are showing a keen interest in acquiring the right to build autogiros.

There was no one in the Autogiro Company organization with enough mechanical engineering knowledge and experience to improve the rotor hub and develop a mechanical starter, so Joseph S. Pecker of the Machine Tool and Design Company has been retained to assist Mr. Larsen in this phase of the work. The mechanical starter has been an outstanding contribution to the American development of the autogiro.

No aeronautical innovation of the last twenty years has attracted such widespread interest as the autogiro. Even the most sceptical or hostile have watched it closely for it is the first fundamentally new type of heavier-than-air craft to give really successful demonstrations. While it remained in Europe, American interest was academic. Since it came to this country, interest has been very lively and practical.

¶ In the July issue we described in detail the form that the type has taken in the latest commercial designs. To develop the background of the autogiro somewhat further Mr. Pitcairn, who was of course responsible for its original introduction into America and for the remarkable subsequent development, has been good enough to recapitulate his own early experiences of autogiration, the considerations that led him to undertake the promotion of De la Cierva's invention in the United States, and the way in which he has set about it.

There are many others who have aided materially in the development of the autogiro in this country but space will not permit me to mention more

The rotor hub, blades and mechanical starter are the most expensive parts for the new licensee to develop and are the least familiar to him of any part of the machine. Consequently, the Autogiro Specialties Company has been organized and licensed to supply these units to licensees. This service, we believe, will save them much time and money. However, licensees are left in complete freedom to build these parts themselves.

Since the first autogiro was brought to this country much progress has been made both here and in Europe. Without going into technicalities, I would summarize this progress briefly, as follows:

Starting the rotor by means of a clutch and shaft connected with the engine makes take-off considerably shorter than that of an airplane. The efficiency of the machine has been very materially increased by improving the rotor blades and fixed wings. The landing gear has been improved in many respects. The stability of the autogiro is now as good as the airplane. Upturned wing tips give it a high degree of lateral stability. Sufficient fin area gives it good directional stability. Proper location of the center of gravity, fixed wings and tilting of the engine lead to satisfactory longitudinal stability. The rotor now operates smoothly. A brake has been developed to stop the rotor after landing. There has been a decided improvement in performance in every respect. Control in very slow flight has been materially increased.

Whatever the ultimate flying machine may be, there can be little doubt that the autogiro utilizes the correct principle of flight—namely, that the speed of the lifting surfaces be independent of the speed of the machine as a whole.

Considerable work has been done with slots and flaps to decrease the possible slow forward speed of the airplane, and postpone its stalling point but every heavier-than-air craft supports itself by deflecting air downwards. In other words, the machine is supported because the air has weight, and since the air weighs so little a tremendous quantity of air must be deflected to support a full sized aircraft. Therefore, if lift and control are to be maintained, it is necessary for the surface or surfaces which deflect the air to move constantly at a high rate of speed. Consequently, it becomes obvious that extremely slow flight requires that the speed of the lifting surfaces be independent of the speed of the rest of the aircraft.

This Spring and Summer a few autogiros have been placed in the hands of the public and the experience gained has been most interesting and useful. There is no question that normal autogiro flying is easier than flying an airplane. However, the machine is capable of doing many remarkable feats and to do these most remarkable things in the most spectacular way requires considerable skill and experience. Because of this, the impression has spread that the autogiro is not so easy to fly after all.

The autogiro is not an airplane and the technique of handling it is different. Even if a new type of machine is intrinsically easier to handle than an old type the effort required to learn the new technique often gives the impression that the new type is more difficult to handle. That which one becomes accustomed to seems easier and better.

The old and the new

I remember when the mail pilots said that the new machines did not compare with the old D H's. It took some effort to sell the old pilots the idea that the new designs of light airplanes after the war were better than the Jenny.

Although the reception of the autogiro in this country, both by the public and the pilots has been most gratifying, it is hard at first for some airplane pilots to believe that the autogiro is easier to fly, but we have found that most of those pilots who have been flying autogiros for some time do not like to go back to flying the fixed wing aircraft.

About 75 different airplane pilots have flown autogiros, many of these men without autogiro dual experience, and with only verbal instructions. None of them had any mishap on the first few flights, except in one case where the wheel brake jammed causing an excessive ground loop which was the fault of the brake and not of the autogiro.

It is true that some of the autogiros have tipped over after contacting with the ground but this has been mostly the result of attempting unusually spectacular flying before becoming thoroughly familiar with the technique of handling the autogiro in situations that would be disastrous with the airplane.

Recently we started a school to find what problems are involved in instructing novices to fly autogiros. We have taken a number of men from our own organization ranging from 25 to 40 years in age, and we have been able to solo them in about two-thirds of the time that would be required for a man of the same age to solo on an airplane. We have permitted these men to continue to solo and our experience, although so far admittedly meagre, has been most encouraging.

My attitude toward the autogiro is perhaps influenced more than anything else by my own experience with it. For the most part, during the past two months, I have been using the autogiro in place of the car, flying daily from my front lawn to the factory in the morning and flying back again in the evening. It has always been my ambition to do this but I never seriously considered landing on the lawn in an airplane.

My family spent the summer at the seashore, about 80 miles away, and I have commuted week ends in the 'giro, landing on the beach in front of the house. This would have been impossible on quite a few occasions with the airplane because of the crowded beach and its narrowness at high tide. With the autogiro, it is practical because of its ability to stop in its tracks where it lands, and because it is much easier to put the wheels down at a predetermined spot.

Several weeks ago, I flew from my home to the factory in weather that was so thick that I would not have ventured forth in an airplane. I flew at about 40 m p h which gave me ample opportunity to see obstacles which might be in my way and afforded the further advantage of being able to turn within an extremely short radius either to avoid thicker weather or obstacles, and all this without danger of tail spin or stalling. Because of flying so slowly, I also had the opportunity to come to a complete stop momentarily and descend into any small field in case the necessity should arise.

I do not wish to misrepresent the autogiro. There is a certain type of spectacular autogiro flying that requires considerable skill and experience. On the other hand, ordinary autogiro flying, including landing in relatively small spaces is not difficult. Naturally, a certain amount of practice will be required for any one to fly an autogiro successfully and naturally the older a man is the longer it will take him to master it.

Realizing its advantages

Although the attitude of many pilots is all that we could ask for, I think it is impossible for an airplane pilot who is not familiar with the autogiro to fully realize its advantages. I have almost completely discontinued flying the airplane on account of the danger of the tail spin and losing lift and stability that accompanies the stall. When flying the autogiro in which the above characterstics are eliminated, I have been delighted with the resulting absence of nervous strain. This is further reduced by the realization that in case of engine failure an autogiro can be put down almost any place any time with much less skill than is required to land an airplane.

The isolation and monotony of flying at 1,000 ft. or higher detracts much from its enjoyment. One acquires a new conception of flying when he becomes familiar with the autogiro. Flying low and slowly with full control and ability to turn in short radii gives a thrill of enjoyment without a feeling of danger.

I am no longer tempted to wager that there will be as many autogiros in ten years as there are automobiles, but I am confident that the practical utility flying machine has at last arrived.

Air transport in the modern manner involves more than the flying of airplanes. The various agencies supplying equipment and materials, the executive headquarters of the airline, and the operating departments are prone to mutual misunderstandings. Their coordination is a serious matter. One way of solving the problem, as set forth here, is through the use of the engineering department as a channel of communication among the various groups and departments concerned.

Grooming an air fleet

Map of routes covered by Eastern Air Transport

WITH the transition of air transportation from the haphazard, under-organized, barnstorming stage to the realm of Big Business, the importance of purely engineering functions as distinct from operations has been steadily on the increase. In the days when 200 miles was a long route, and one or two pilots and airplanes constituted the entire personnel and equipment of an airline, the problem of management was relatively simple, and usually devolved upon one individual who was at the same time chief pilot, chief mechanic, inspector, purchasing agent, and personnel manager. With the growth of the great trunk lines which now span the country the problem of menagement became a hundred-fold more complex. Not only must ground and flying personnel and equipment be maintained and controlled over widely separated areas but the growing tendency to include under one management the manufacture of airplanes, engines, accessories, and certain raw materials and supplies, has added further complications. The coordination of effort among the several units involved has become an engineering problem of a very high order. For this reason the tendency today is toward the establishment of separate engineering departments to exercise a controlling influence on the selection of equipment, the specification of supplies, and the supervision and standardization of maintenance.

In general, two distinct types of transport operation have evolved in the country today. The first offers frequent service over a relatively short route. The frequency of service and short haul make possible a highly concentrated organization in which one individual may be able to take care of several diversified functions. Organizations of the second type, which are actually much more common than those of the first, are represented by Eastern Air Transport, Inc. With its operations spread over the entire eastern seaboard from New York to Miami, and its equipment varying in character from the single-engined Pitcairn Mailwings, to the five-passenger Curtiss Kingbirds, and the eighteen-passenger Curtiss Condors, it is obvious that a much greater degree of coordination is required than in the case of the more highly concentrated activities of the shorter lines.

The headquarters of the line are in Brooklyn, and the responsibility for all operations rests with H. A. Elliot, general manager. Of all the departments under Mr. Elliot's supervision the two with which the present article is primarily concerned are "operations" under C. H. Dolan in Atlanta and the engineering department under Mr. R. G. Lockwood in Brooklyn. The operating department looks after all matters connected with the flying and maintenance of airplanes, engines, and accessories, controls all flying and shop personnel, purchases and stores all materials and

The Atlanta Depot

supplies, in short, it must be ready at all times to meet the mail and passenger schedules set by the traffic department. The engineering department occupies a parallel position in the organization, making contact with the operating department at a number of important points. In the following paragraphs, its principal functions are outlined, and a description of the general servicing routine on the line is given in some detail to show the manner in which its influence is felt on the purely operating functions.

The engineering department is not directly responsible for the actual conduct of maintenance and servicing operation, but it exercises two highly important functions in this connection. In the first place, the entire inspection department is responsible directly to the chief engineer, and local inspectors are not under the control of the local depot or field managers. This system affords a double check on the airworthiness of the plane and tends to reduce the possibility of any doubtful equipment being flown. The engineering department inspectors look over every plane as it comes in from a run and must pass on its condition before it goes back into service after having been laid up for any reason.

Engineering functions

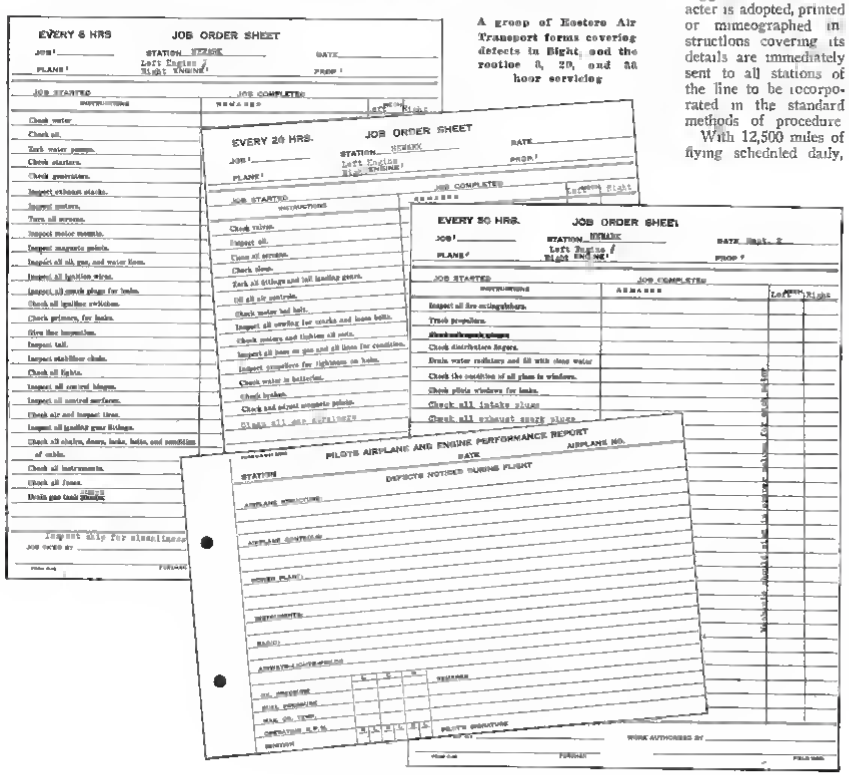
Although the Atlanta Depot (an operating department unit) purchases and carries in stock all material and supplies for the operation of the entire line, it follows the recommendation and specification of the engineering department in making its purchases. Whenever trouble is encountered in any equipment or accessories in any of the shops, an "Unsatisfactory Report" is immediately made out by the foreman in charge of the work and forwarded direct to the engineering office in Brooklyn. This report is very simple in make-up and includes the following information:

1. Date. 2. Station. 3. Name of manufacturer. 4. Article. 5. Model. 6. Airplane number. 7. Description of trouble and recommendations or remarks. 8. How repaired.

Immediately upon receipt of such report the engineering department gets in touch with the manufacturer of the defective article to endeavor to straighten out the difficulty and to prevent its recurrence. Recommendation is then made to the purchasing department with reference to the procuring of new equipment of the same sort. In this way the engineering department is constantly in touch with equipment difficulties encountered in the shop and thus has a rational basis for writing its specifications.

The engineering department functions also as a clearing house for the many suggestions for improvement in equipment, materials and methods that constantly come in from the field. The men in the shops submit their ideas to the field managers or depot superintendent, and those that are of obvious merit are passed along to engineering headquarters for investigation. Once a suggestion of this character is adopted, printed or mimeographed instructions covering its details are immediately sent to all stations of the line to be incorporated in the standard methods of procedure.

With 12,500 miles of flying scheduled daily,



A group of Eastern Air Transport forms covering defects in flight, and the routine 6, 24, and 50 hour servicing

over a territory varying in character from the thickly settled urban districts of the north, to the rough, treecovered Piedmont counties of the Carolinas and the swamps of Florida, it is obvious that a system of inspection and maintenance of equipment of a very high order must be behind the excellent record for safety and regularity that Eastern Air Transport has maintained. The problem is complicated by the extent of country over which the line operates, which greatly multiplies the required number of repair bases and intermediate servicing stations. No small measure of the success that this line has enjoyed in maintaining its equipment is due to the complete standardization of methods at all its repair points. All forms which are used in connection with repair work or inspection of any sort are fully standardized and printed instructions for the work to be done at any station have been compiled by the engineering department, so that, whether a particular job is done at Miami, Atlanta, or Newark, it is done in exactly the same fashion and full records covering it are instantly available. The chief engineer is constantly in touch with all field and depot managers, and makes a personal inspection of the line and shop equipment about once a month.

Maintenance routine

At the present time there are two main repair points for the system in both of which engineering department men are permanently stationed. The Atlanta Depot now takes care of all overhaul and maintenance on the Curtiss Kinghirds and the Pitcairn Mailwings. The shop is equipped to handle any sort of overhaul on airplane structures, and since both of the above types of machine are powered with Wright air-cooled radial engines, equipment is available for complete overhaul of this type on a production scale. Heretofore the use of the Condors has been restricted to the New York-Richmond run and all repair work on this type has been concentrated at Newark. Since the plant of the Wright Aeronautical Corporation is very close, no attempt has been made to install equipment for the overhauling of the water-cooled Curtiss Conqueror engines used in the Condor. Minor repairs and adjustments are made in the Newark shop, but for overhauls or any major replacements, the engines are sent to Paterson by truck for factory attention. With the present plan for extending the Condor schedule farther south, and with the possibility that, where traffic demands, the large types will eventually replace the Kingbird, plans are now being made to enlarge the Atlanta Depot so that eventually all work on both the Condors and their engines will be concentrated at that point also. Under the present limited schedule however, the Newark shop will be maintained as the repair base for the larger machines.

All intermediate fields are now equipped to take care of minor repairs or adjustments which may become necessary on any machine away from the repair bases. At certain junction points, such as Richmond and Jacksonville, a limited supply of spares is maintained, usually including at least one spare engine and one or two spare planes. If any serious trouble develops on any run, the plane in question can then be grounded and one of the spares sent out to complete the schedule. Sufficient work is then done to put the defective machine into condition to fly it back to Atlanta, where troubles are completely remedied and the machine fully checked before being placed again in service.

Under present operating conditions each airplane of the line flies approximately 6 hours per day. During each flight the pilot notes any defects in the airplane which should be called to the attention of the maintenance department, and after landing enters his observations on a form called "Pilot Airplane and Engine Performance Report." Immediately upon the completion of a run, an engineering department inspector looks over the troubles encountered and turns the form and the machine over to the line crew at the station. The defects are attended to at once, and both engineering department's inspector and mechanic certify their completion by their signatures on the back of the form.

At the end of each 6 hours' flying, or approximately every day the machine goes into the shop accompanied by a job order sheet for a regular 6 hour inspection. The machine is gone over from end to end checking the points entered on the job order sheet with all irregularities noted, and with the mechanics initialing each item of work done. Before the machine then leaves the shop the job order sheet must be approved by an engineering department inspector as well as the line foreman. The form is then signed by the field manager and filed in his office.

At the end of every third day or approximately for every 20 hours of airplane operation, the machine is removed from service for a full 24 hours and given not only the 6 hour routine checking but also a more thorough inspection and lubrication including the changing of all engine oil. The items listed on this inspection may be seen by reference to the accompanying illustration. As before the work must be certified by inspector, line foreman, and field manager.

After every 50 hours, or at intervals of approximately nine days, a 50-hour job order sheet is made out covering additional items for attention, and at intervals of 100 hours the plane is given a thorough inspection which covers every item on board in considerable detail. The latter is the most important check of all and will be discussed in detail in the following paragraphs.

The 6 hour sheets are white the 20-hour blue, and the 50-hour sheets are red. In this way it is obvious at a glance exactly what work is being done on any plane at the moment.

Unfortunately space does not permit reproduction of the "Thorough Inspection Report" for it occupies five closely printed pages and covers practically every important part of the airplane. Copies of this report are forwarded to the chief engineer enabling him to keep a first hand check on the condition of all flying equipment. Some idea of its scope may be obtained from the following brief outline in which the major assemblies are listed. The figure in parenthesis accompanying each heading indicates the number of individual items which are specified for attention on the report. As in all other reports space is provided for remarks by the inspectors and for the initials of the mechanic responsible for the repair of any particular job.

The group assemblies in the order of their appearance on the report are as follows: 1. Power plant (27). 2 Engine controls (5). 3 Engine mount (5). 4 Landing gear (8). 5 Center section (7). 6 Pilot cockpit (29). 7 Passenger cockpit or compartment (11). 8 Fuselage (11). 9 Wings and ailerons (21). 10 Stabilizers, elevators, and rudders (12). 11 Control cables (14). 12 Electrical equipment (13).

Servicing manual

As a guide for the inspectors and mechanics making the thorough inspection reports at 100 hours, the engineering department has prepared a very complete manual taking up each point of inspection individually, and giving definite instructions covering what to look for, and how to remedy defects when found. The manual in its present form is made up in three parts covering engines, airplanes, and radio installations. The thoroughness with which these instructions have been compiled is indicated in the latter group where some 67 individual instructions are given for the routine inspection of the Model D Radiomarine receiving apparatus used on the Pitcairn Mailwings.

The thoroughness of the various checks is in itself an excellent indication of the reason why Eastern Air Transport has been able to keep its planes in the air with a minimum of trouble. As in every industry, successful operations on a large scale must be predicated upon systematized and standardized methods. This fact is well recognized by the management of Eastern Air Transport and it is to be expected as time goes on that its efforts in this direction will bear fruit in increased efficiencies and constantly decreasing maintenance costs.

Transport planes for profit

By A. A. Gassner

One of the heritages of commercial transport plane design from its military origin is an almost complete disregard for economy in operation. With the increasing competition between airplanes and other transport media, it has been found that operating efficiency must be considered in the earliest stages of transport plane design. In this, the first of two articles, Mr. Gassner discusses the application of general principles for predicting efficiency in one, two, and three-engined transport planes.

THE aviation industry is well past the pioneering stage. From now on, what we need is less invention and more application of the basic principles we have learned. The design problem must be analyzed much more carefully and systematically than heretofore if a satisfactory product is to be the outcome. The new plane must not only satisfy the pilot by having good flying characteristics good visibility and a spacious cockpit with all controls and instruments conveniently located, it must not only please the air traveling passenger with a well appointed large cabin, comfortable chairs, and ample windows offering good vision of the landscape below,—it must satisfy the accountant and comptroller of the air transport company which is using it on its lines. A plane which has all the other merits to a large degree, a plane which is considered more desirable than any competitive machine on account of its performance, will not be used very long on any modern airline if its record on economy is poor.

It is an open fact that close contact between the airplane manufacturer and the ultimate user has been developed only during the last few years. In the early days any airplane was considered good which was able to keep itself in the air for a few minutes. Later on the necessity of making the plane more stable brought many improvements in design, and still later the purchaser demanded greater load capacity and higher speed. The advent of commercial aviation during the first years after the war meant a readjustment of airplane designers' point of view. Pioneering of a different kind was then required. Up to about three or four years ago the plane manufacturer told and in many cases had to tell the airline operator what type of plane would be best suited for his purposes. If the plane builder knew more about airplanes than the purchaser, the best suited machine was of course in many instances the firm's current production model.

Operation records of air transport companies have made it possible to investigate the problem from an economic point of view. In an article which appeared in the October issue of AVIATION the writer has established a formula for calculating the transportation cost per passenger mile for a given plane under certain assumptions as to life of plane and engine, use of the machine during a year's time, and cost of insurance, hangar rent and pilots' expenses.

We shall now investigate how the design characteristics of the plane with given engine or engines have to be chosen to obtain the most satisfactory compromise between performance and transportation cost per passenger mile.

A number of specification requirements for transport planes are prefixed. These are: Landing speed with full load must not exceed 65 m.p.h., minimum rate of climb at sea level must be 600 ft. per min., cruising speed must be at least 120 m.p.h., range without refueling must be at least 500 miles at cruising speed, transportation cost per passenger mile shall not exceed 4 cents, and the machine must be equipped for night flying. For multi-engined plants an additional requirement is that the fully loaded airplane must be capable of maintaining an altitude of at least 4,000 ft. above sea level when one engine is out of commission. This requirement is absolutely essential for any plane equipped with more than one engine, if the installation of multiple individual power plants is not to reduce but to increase the safety and reliability.

Other limitations are of course possible, depending on the specific condition of the route to be flown regularly by the transport plane and on the demands of the operator as to space for passengers and freight. These may involve a minimum limit for ceiling, a higher rate of climb to take care of take-off conditions at high altitudes, or a longer range. The limitations stipulated above, however, will prove sufficiently rigid for a wide range of conditions of operation and the determination of the influence of other limitations on the transportation cost can be calculated easily in much the same similar manner as is shown here for the basic case.

The basic design characteristics of any plane are power and wing loading. To find the relation between the above given limit of plane performance and the wing and power loadings we use groups of basic performance formulas developed by Edward P. Warner and Lieut. Walter S. Diehl, which are found to give very consistent results when checked against actual proven performance of existing planes. As the same formulas are used for all machines under investigation, an error of a few per cent can be neglected as having no material effect on the final general conclusions.

Edward P. Warner's formula for maximum speed of single-engined planes of normal design is

$$V_{max} = 137 \left(\frac{P}{S}\right)^{\frac{1}{6}} \qquad (1)$$

where P is the total engine hp. and S is the wing area in square feet.

If the plane is designed with every possible attention to smoothness of the external surfaces, with streamlining carried to the limit and with clean designed or retractable landing gear, this formula can be altered to read

$$V_{max} = 180 \left(\frac{P}{S}\right)^{\frac{1}{6}} \qquad (2)$$

For design and checking purposes it is more convenient to use directly wing and power loading in this formula instead of the term P/S, and Equation 2 can be written as follows:

$$V_{max} = 180 \left(\frac{W}{S}\right)^{\frac{1}{6}} \left(\frac{P}{W}\right)^{\frac{1}{6}} \qquad (3)$$

In this study the value 150 is used throughout, as it is quite natural that in any new design closest attention will be given to perfect streamlining. Fig. 1 gives possible combinations of wing and power loadings for various required maximum speeds.

The equation for stalling speed is

$$V_s = \sqrt{\frac{18}{S \times k_{y\,max}}} \qquad (4)$$

For modern high-lift airfoils as used on transport monoplanes the value for $k_{y\,max}$ is between 0.0036 and 0.0038. With the latter value and in consideration of the ground effect, the relation between wing loading and landing speed can be taken as follows: Landing speed 66 m.p.h.—maximum wing loading 17 lb. per sq.ft., 65 m.p.h.—16.5 lb. per sq.ft.; 64 m.p.h.—16.0 lb. per sq.ft.; 63 m.p.h.—15.5 lb. per sq.ft., 62 m.p.h.—15.0 lb. per sq.ft., 61 m.p.h.—14.5 lb. per sq.ft., 60 m.p.h.—14.0 lb. per sq.ft.

Edward P. Warner gives in his book, "Aerodynamics," on page 313, a formula for the rate of climb at sea level. This formula of 1923 has been modified to be more consistent with actual flight test results and for today's planes we can write for rate of climb at sea level

$$\frac{dh}{dt} = \frac{2800\ P}{W} - 300 \sqrt{\frac{W}{S}} \qquad (5)$$

We have previously stipulated that the rate of climb must be at least 600 ft. per min. and the maximum possible values for P/W as function of W/S is therefore

$$P/W = 0.0201 + 0.013 \sqrt{W/S} \qquad (6)$$

The values for wing and power loading required for obtaining desired maximum speed, rate of climb and landing speed have been plotted in Fig. 1, which shows therefore the basic limitations for design characteristics for single-engined planes. Combinations of wing and power loadings below the line of landing speed of 65 m.p.h. to the left of the curve of rate of climb of 600 ft. per min. and above the line of maximum speed of 150 m.p.h. fulfill our basic requirements, as far as performance is concerned.

An investigation in similar manner will now be carried out for twin and three-engined planes. The basic performance requirements as previously laid down continue to be in force. The requirement that the fully loaded plane must be able to maintain safely an alti-

Table 1—Maximum allowable wing loadings for given power loadings for absolute ceiling of 6,000 ft. for multi-engined planes flying under full load with zero engine out of operation.

Power loading with min. engine not operating	Power loading twin-motored planes minimum operating	Power loading three-motored planes minimum engines operating	V_s (Stalling speed in m.p.h.)	w/s (Maximum allowable wing loading lb. per sq.ft.
12.00	6.00	8.00	101.30	30.90
13.00	6.50	8.66	93.50	33.20
14.00	7.00	9.33	86.70	28.60
15.00	7.50	10.00	81.00	24.95
16.00	8.00	10.66	76.00	22.60
17.00	8.50	11.33	71.50	19.40
18.00	9.00	12.00	67.50	17.30
19.00	9.50	12.66	64.00	15.60
20.00	10.00	13.33	60.75	14.05
21.00	10.50	14.00	57.80	12.75
22.00	11.00	14.66	55.30	11.65
23.00	11.50	15.35	52.60	10.60
24.00	12.00	16.00	50.60	9.74

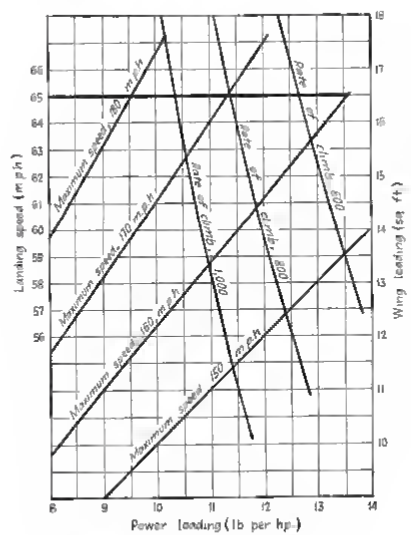


Fig. 1: Wing and power loading limitations for single-engined transport planes

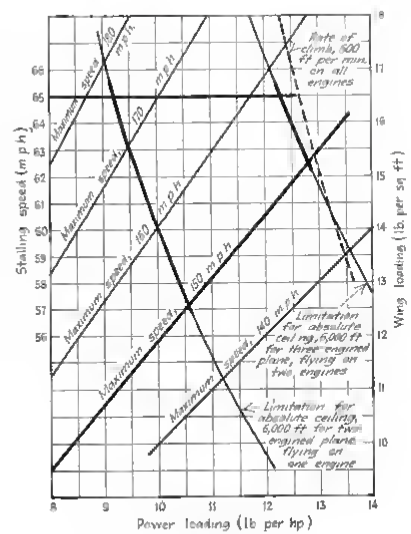


Fig. 2: Wing and power loading limitations for twin and tri-engined transports

tude of 4,000 ft with one engine out of commission is approximately equivalent to a required absolute ceiling of 6,000 ft under these operating conditions Diehl's book, "Engineering Aerodynamics," contains on page 237 a formula for calculating the absolute ceiling of a plane This formula is here used to determine the limitations for wing and power loading combinations According to this formula and to its graphs, for an absolute ceiling of 6 000 ft. of a plane with a lift-drag ratio of 10, the following equation must be fulfilled

$$V_s \frac{W}{P} = 1350 \qquad (7)$$

In this equation V_s is the stalling speed and W/P is the power loading This formula must be revised for our case, because the actual power loading of a twin-engined or three-engined plane flying with one engine out of commission cannot be calculated on the basis of the rated hp of the operating engines The efficiency of the power plant of the multi-engined plane drops when one engine is not operating This and the fact that rudder or aileron action or both will be required to keep the plane on its course necessitate the introduction of a correction factor Equation 7 is therefore revised for this case to read

$$V_s \frac{W}{P} = 0.8 \times 1350 = 1015 \qquad (8)$$

Table I gives the maximum allowable values of wing loading for various power loadings of twin and three engined planes The power loading used in Equation 8 is based on the nominal rated hp of the engine or engines which remain in operation The required wing loading is calculated for given stalling speed by use of Equation 4 and by considering a maximum lift coefficient of the wing of $k_y = 0.0038$

The wing and power loading combinations as required for given maximum speeds are calculated in Table II from Edward P Warner's formula for multi-engined planes, which reads

$$V_{max} = 107 \, (P/S)^{0.3} \qquad (9)$$

where P is the total rated engine hp and S is the wing area In square feet If the plane is designed with every attention given to smoothness of external surfaces with streamlining carried to the limit and with clean designed or retractable landing gear, this formula can be revised to read

$$V_{max} = 140 \, (P/S)^{0.3} \qquad (10)$$

As in the case of the investigation of the single-engined plane, it is more convenient for design purposes to use wing and power loading in this formula instead of the term P/S, and Equation 10 can be written

$$V_{max} = 140 \, (W/S)^{0.3} \times (P/W)^{0.3} \qquad (11)$$

Fig 2 gives the limitations for wing and power loadings as calculated in Tables I and II Combinations of wing and power loadings below the line of landing speed of 65 m.p.h., above the line of maximum speed of 150 m.p.h , and to the left of the line of limitations for absolute ceiling of 6 000 ft. when flying with one engine out of operation, fulfill the basic requirements as far as performance of these multi engined planes is concerned. It is interesting to note how much the ceiling limitation narrows down the possible field of wing and power loading combinations for twin-engined planes flying on one engine The curve of limitations for a required rate of climb at sea level of 600 ft. per min is indicated for reference

Table II: Possible wing and power loading combinations for maximum speed of multi engined planes.

Power loading all engines operating	Required maximum speed in m.p.h. 140	150	160	170	180	190
	Minimum wing loading in lb. per sq.ft.					
7.00			9.00	11 60	15.35	15.30
8 00	9.00	9 55	11 25	13 15	15 25	17 50
9.00	10 75	12.60	14 00	17 10	18.65	
10 00	10-00	11 90	14 00	16 40	19 00	
11.00	11.00	13 10	15 45	18 10	20.05	
12 00	12 00	14 50	16 85	19 70		
13.00	13.00	15 50	16 25			
14 00	14 00	16 70	19 65			
15.00	15.00	17 90				
16 00	16.00	19 10				

The establishing of visible relations between prefixed performance requirements and wing and power loading combinations leaves the possibility of building twin-engined planes with power loadings up to 10 55 lb per hp and wing loadings of values lower than 16 5 lb per sq ft and limits power loadings for tri-engined planes to a maximum value of 12 80 lb per hp

Our problem is narrowed down to an investigation as to which planes within the already determined limitations can be operated at a cost of 4 cents or less per passenger-mile

Single engine planes will be investigated first, based on the findings as given in Fig 1 We can for instance combine a power loading of 10 lb per hp with wing loadings between 10 and 16½ lb per sq-ft. This would give a series of planes with varying wing area and therefore varying overall size. The machine with 10 lb per sq-ft wing loading would have 65 per cent more wing area than the one with 16½ lb per sq ft wing loading Which means of course that the fuselage and tail surfaces would have to be larger and the weight empty would be higher for the smaller wing loading factor.

Cost and weight of engine and accessories have very great influence on the price and weight empty of the plane In this study we will first analyse a mail and passenger plane equipped with one radial air-cooled engine of 575 nominal rated hp By selection of the engine, part of cost and weight of the airplane is also fixed, irrespective of size and detail design of the plane We have in addition to figure with the fact that instruments for control of engine and of fight, as tachometer, fuel and oil pressure gauges, fuel quantity gauges, altimeter, bank and turn indicator, air speed indicator, etc., have same weight and cost for all types of single-engined planes, provided of course that same high grade of instruments is used This is also the case for various parts of the fuel system, landing gear, electrical equipment, and miscellaneous furnishings. Table III gives the weight and total net price of these components This net price is to be understood as the price at which the airplane manufacturer can purchase these parts at present time, and a sum of 10 per cent of the total has been added to take care of handling charges and capital interest expenses as incurred by the manufacturer of the plane

The group of parts to be manufactured by the airplane firm is also identical for all types of planes equipped with the selected type of engine Their weight and cost is fixed, irrespective of size of plane. In the power plant group we have the exhaust manifold, engine nose cowling, engine ring cowling (Townsend ring), oil tank, oil pipe lines, firewall, engine controls, and miscellaneous brackets and fittings, which have a total weight of 150 lb. and a cost of approximately $650 Flying controls and equipment of the pilot's cockpit are also not affected by the type and size of the plane In this group we can enumerate pilot's control stick or wheel assembly, rudder pedal assembly, stabilizer adjustment assembly in cockpit, pilot's seat with cushion, pilot's cockpit floor, instrument panel without instruments, brake lever assembly, cabin heater assembly, and a number of brackets and fittings for various purposes Their total weight aggregates to 125 lb and their manufacturing cost is approximately $700 Above two groups of parts of fixed weight and cost, irrespective of type of plane have therefore a total weight of 275 lb and a manufacturing cost of $1,350 With an additional 20 per cent for sales expenses and net profit, the sales price of this group amounts to $1,620

Table III: Itemize purchased parts of fixed weight and price, for a 575 hp single-engined plane, irrespective of type and size.

	Weight (lb.)	Price
Power plant: Engine with carburetor fuel pump, general or drive, primer pump, starter, radio shielding two-bladed metal propeller Total	675	$6,250
Instruments. Tachometer oil pressure gauge, fuel pressure gauge, oil thermometer altimeter, airspeed indicator bank and turn indicator compass Total	10	200
Fuel system. Fuel level gauges, fuel strainer, fuel cocks, emergency hand fuel pump, fuel pipe fittings, etc Total	25	115
Landing gear parts: Wheels with brakes (36x8); tires and tubes; tail wheel also-pneumatic shock absorber Total	220	400
Electrical system. Battery with box electric inertia starter generator landing lights, navigation lights voltmeter, ammeter cabin and instrument lights and switches electric cables, terminals junction boxes, etc Total	190	800
Miscellaneous equipment Pressure fire extinguisher; first aid kit, hand fire extinguishers pilot's safety belt brackets and controls for flares Total.	30	95
Sub-total	1,450	$7 830
Handling charge and capital interest 10 per cent		785
Total		$8 613

Our group of fixed weight parts and cost is now complete and we can proceed to the investigation of the airplane market, and all engineering and tool expenses would have to be carried by these.

We have enumerated weight and cost of such parts which are identical for all planes of varying size but equipped with the same type of engine. Our next step will be to investigate the parts which change with the size of the plane As a measure of this size we choose the wing area

Table IV contains weights and cost of various components and certain proportions will be noted between wing area and the column figures Weight of fuel tank is for instance higher for the plane with larger wing area, because it will be slower than the smaller one, equipped with same engine, and will therefore require more fuel capacity for same range

The planes discussed in this study are assumed to be all of similar design and of cantilever monoplane type In-vestigations and comparisons of existing

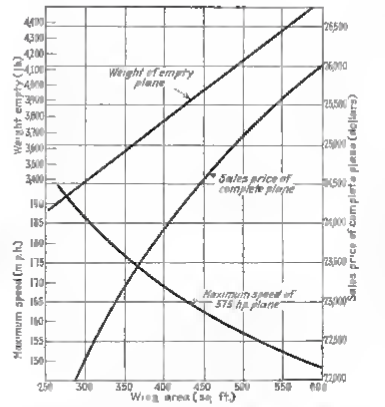


Fig 2 Dependence of weight empty sales price and maximum possible speed on the size of a 575-hp single engined plane

planes of all metal, of composite metal and wood, and of all wood construction seem to indicate that very small differences exist in cost and weight between these types and the values given in Table IV can be taken as fair averages. Special design and manufacturing features will of course require individual treatment.

Wing weight has been assumed to be increasing from a value of 1 85 lb per sq ft for the 300-sq ft wing to 2 15 lb per sq ft for the 600-sq.ft. wing, with values for in-between areas in proportion These figures are believed to be reasonable for full cantilever wings and include weights of aileron, aileron control system in wing, inspection doors, brackets and fittings for landing lights and navigation lights, conduits for electric light wires, radio bonding and fittings for fuel tank supports The manufacturing cost of the complete wing is assumed to decrease from a value of $1 10 per sq ft. for the 300-sq ft. wing to $0.80 per sq ft. for the 600-sq ft wing

The above figures take into consideration that a great number of smaller parts and fittings are identical for small and large wings and that cost of spars, ribs, covering, painting, etc., does not increase in direct proportion with total wing area

The area of horizontal tail surfaces is approximately 15 per cent of the wing area. The weight of the tail group, including stabilizer elevator, fin, rudder and braces does not increase in direct proportion with the wing area and has been taken as decreasing from a value of 14 per cent of the wing weight for the plane with the 300-sq ft wing to 12 5 per cent of the wing weight for the 600-sq ft plane. Weight and cost of fuselage, cabin walls and floors, cowlings, landing gear parts, etc., are included in Table IV. A sum of 20 per cent of the sub-total has been added to take care of sales expenses and net profit of the airplane manufacturing firm. All cost figures include labor factory overhead, cost of material and administration expenses Engineering cost, as outlined previously, is included in the development and tool expense figure.

Table V contains all items of weight and cost for planes of different wing areas, as enumerated above We find

Table IV Weight and cost of parts of a 575-hp single-engined plane which differ with size of plane

Wing area (sq.ft.)	300 lb	300 dollars	400 lb	400 dollars	500 lb	500 dollars	600 lb	600 dollars
Wing	555	$ 300	780	4 000	1 020	4 500	1.290	4,800
Tail group	80	520	105	695	135	675	165	700
Fuselage	450	2,500	500	2 800	540	3 000	570	3 150
Cabin floors and walls etc	150	560	160	640	175	700	195	780
Fuselage cowling, doors, etc	90	515	100	550	110	595	120	420
Fuel tanks	75	200	90	250	100	280	110	310
Landing gear less wheels, etc	170	500	195	575	210	650	225	725
Control cables	30	100	35	105	40	110	45	115
Miscellaneous	60	350	70	575	80	400	90	425
Total	1.660	8 345	2,055	9 700	2,410	10,700	2 910	11 425
Sales expenses and net profit 20 per cent		1,669		1 940		2,140		2,285
Sales price		10,014		11 640		12,840		13 710

Table V Dependence of weight empty and of sales price on size of 575-hp single engined plane

Wing area (sq.ft.)	300 lb.	300 dollars	400 lb.	400 dollars	500 lb.	500 dollars	600 lb.	600 dollars
Outside purchased parts of fixed weight and price	1,450	8,613	1,450	8,613	1,450	8,613	1,450	8,613
Parts manufactured by plane firm; fixed weight and cost	275	1,620	275	1,620	275	1,620	275	1,620
Cost of assembly work		1,050		1,050		1,050		1,050
Development and tool expenses*		1,000		1,000		1,000		1,600
Total fixed weight and cost	1,725	12,283	1,725	12,283	1,725	12,263	1,725	12,283
Weight and sales price of parts which change with sizes of plane*	1,660	10,014	2,035	11,640	2,410	12,040	2,810	13,710
Weight empty (lb.)	3,385		3,760		4,155		4,535	
Sales price (dollars)		22,297		23,023		25,125		25,993
Percentage of fixed weight and price to total	50.9	55.0	45.8	51.2	41.7	48.8	38.0	47.2

*See Table III

that the weight of the empty plane of 300-sq ft. wing area is determined to the extent of 50.9 per cent by the weights which are fixed and identical for all machines of this type which are equipped with the 575-hp engine selected. This value amounts, however, only to 38 per cent for the plane with 600 sq ft wing. For the 300-sq ft plane the cost of outside purchased parts of fixed price, which are engine with accessories and propeller, amounts to 38.5 per cent of the total sales price of the plane, and to 33.3 per cent for the 600-sq ft machine. This means that the airplane firm building the 300-sq ft plane would have to save expenses amounting to 16.3 per cent of the sales price of the parts of own manufacture to be able to reduce the sales price by 10 per cent. Fig. 3 shows the values of Table V plotted for various wings areas. It is interesting to note that the curve of weight empty is a straight line and that the sales price curve declines with increasing wing area.

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Planning the small airport

Some hints from the North-Central Airport Conference

VALUABLE data on installation and maintenance costs of medium sized airports were divulged by C. I. Stanton, airways superintendent of the Department of Commerce, in a paper at the North-Central Airport Conference held at Indianapolis Sept. 24-25 under the auspices of the Aeronautical Chamber of Commerce. His discussion was based on the government's experience with the preparation and operation of the 406 active intermediate fields which have been installed since the Aeronautics Branch came into being. While the government is able to do this work at less cost than most individual communities by virtue of its position in holding competitive building and securing quantity orders, including contracts for field construction by groups, its experience is indicative of practices which may be profitably emulated by commercial operators or by either the large or small community desiring a medium sized airport.

Probably the most important lesson is that adequate all-weather landing fields need not be unduly expensive if proper care and vision are exercised in the selection of the tract and in planning its development. This means indirectly that the passion for elaborate airport items which has characterized so many costly installations in recent years is not necessarily justified.

The early intermediate fields comprised about 40 acres each and only $500 were allotted for conditioning each one. Fields which could be used practically in their natural state or with very little preparation, such as the cutting down of a few trees and removal of fences, were the type selected. The increase in size and speed and loads of civil aircraft forced more elaborate installations, but with the same care and economy. The fields now being put in commission comprise about 100 acres, have landing strips ranging from 2,500 to 3,000 ft long and 600 ft. wide, the lighting is the latest, and the obstructions are carefully eliminated or marked. Intermediate fields usually are L, T or X-shaped and bevelling of the intersections provides additional landing area in case of crosswind landings. Hard surfaced landing strips are not installed by the government because of their expense, but careful study of the soil insures selection of a site which will be available for all-year operations.

The average cost of an intermediate field has risen to about $7,500, which covers all items except the leasing of the site. The civic community or commercial operator basing the investment on the government's experience would have to add the cost of the land. The above amount includes:

Lighting and marker equipment	$1,050
Installation contract	2,675
Freight	134
Power line extension	420
Field preparation	3,160
	$7,447

If commercial current for the lights is not available local gasoline-driven electric generators and gasoline tanks costing about $2,030 must be provided. Field preparation alone costs:

Grading	$836
Clearing, grubbing and surfacing	677
Seeding	299
Removing obstructions, clearing approaches	214
Drainage	510
Fencing	304
Ground marker	130
	$3,160

The grading item covers the moving of only 2,300 cu.yd of earth whereas the moving of an average of six inches of earth over two intersecting 1,800x 600-ft. runways would involve 33,333 cu.yd. However, such care is exercised in the selection of sites, that even in rough country the grading seldom exceeds a maximum of 10,000 cu.yd in one field. Gravelly sub-soil is the most desirable for the airport surface. An impervious sub-soil located close to the surface is to be avoided. A continuous slope not exceeding 3 per cent is acceptable and, unless there happens to be some peculiar natural drainage, there should be some grade to carry off surface water. A certain amount of porous material with a natural binder is desirable. Very little drain pipe is installed and then usually to care for special conditions in a small area of the field. The cover crop is important and varies with the locality. It should be possible to drive over the field, after covering, in an automobile at the rate of at least 30 m.p.h. without severe jounces.

Maintenance amounts to about $2,000 per year. The lighting accounts for half of this:

Electric current 10,000 kw-hr. @ $0.06	$600
Lamps	91
Paint and miscellaneous supplies	100
Repairs	150
	$941

The balance includes field rental, salary of caretaker and district office supervision.

A discussion of the methods and apparatus for reclaiming engine oils

Reducing the lubricating oil inventory

By J. C. Schillaber

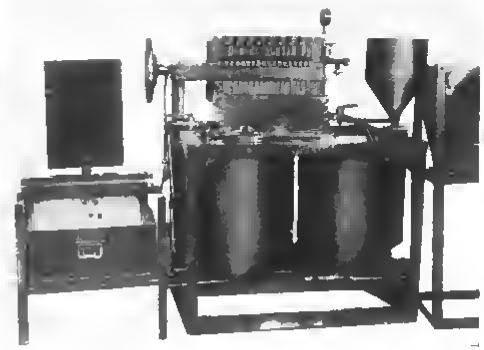
IN AN effort to reduce lubricating oil expense in transport operation, many of the major airlines are using, or considering the use of, lubricating oil reclaimers. Devices of this type have been in use in the bus transportation field for some time, but their application to airplane engine operation is comparatively recent.

As the oil reclaimer was developed primarily for automotive use, it has been necessary to modify the design of this apparatus to some degree for aeronautical application. At the present time, however, several manufacturers are offering units designed specifically for aeronautical use. The most important requirement in reclaimers for aircraft engine oil specifically is wide range of temperature control. This calls for large easily read thermometers, well constructed automatic devices for temperature control, and accessibility for quick and fine adjustment. A comparison of the characteristics of new and reclaimed oil made in the test division of the Wright engine plant is shown in the tabulation on page 642.

There are three kinds of dirt to be removed from crankcase drainage, (1) carbon and tarry matter, (2) metal particles and their oxides, and (3) road dust and silica. Overhead air intakes, air strainers, grassed-over landing field and operation above the lower levels of air contamination, reduce road dust and silica to a minimum. An analysis recently made of carbon scraped from a piston head of an engine at the Newark Airport, showed only 3.15 per cent road dust and silica. In Texas, where the dust is blown to high levels, manufacturers experience much difficulty in protecting their engines. Whenever road dust and silica are liable to run to high proportions in the drainage, tests should be made frequently to insure that the method of removal is adequate. The remainder of the dirt, carbon and metal, is generally taken care of satisfactorily by filtering.

Due to the use of high grade of gasoline and frequent changing of oil, acidity is reduced to a minimum. The acids ordinarily present in lubricating oil are weak and are not harmful unless they exist in greater quantity than is usually found in new oil. They may be beneficial to a certain extent since they

The TAG two-tube Saybolt Viscosimeter

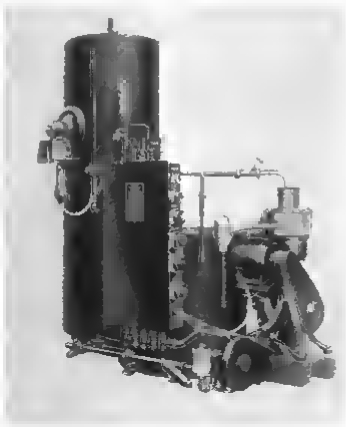


Right: The Allen Pure-A-Flex manufactured by Johnston & Jennings, is made in capacities of ½ and 2 gal per hour

increase the property of oiliness. Neutralization of reclaimed oil is generally obtained by the use of clays or earth filters

Reclamation processes

There are two ways of handling crankcase drainage for reclaiming, (1) it can either be sent to an oil laundry already equipped to do such work, or (2) a reclaimer can be purchased. In the case of the oil laundry the charge is generally 25 cents per gallon for finished oil, and since their work can always be checked, it is a convenient method for those who have only small amounts to handle. In making a selection of plant the first thing to ascertain is whether it is reclaiming miscellaneous drainage and selling it, or keeping customers' oil segregated. There is no object in giving an expensive oil to a laundry for reclaiming and having a cheaper product returned. Oil should be returned in clean barrels. It may be considerably off color, but it should always conform closely to the specifications of new oil.



DeLaval reclaimer of 55 gal capacity

Reclaimers generally put oil through two processes, (1) heating to restore viscosity, and (2) filtering to free it from suspended matter. Heating is done electrically with suitable control. Certain machines heat the oil in batches, others use a continuous process where heat is applied to small quantities of the oil as it passes through the apparatus. The systems are equally effective, but with the continuous process the heat can be regulated while the run is being made. After the diluent has been evaporated, the next step is to remove the suspended matter, and it is here that the greatest difficulties and also the greatest differences in the processes occur.

There are a number of different methods of removing particles of dirt, but the filtration process is probably the most widely employed. Fullers earth, diatomaceous earth, or some of the clays are all used, but Fullers earth has been particularly successful as it has decolorizing properties, and returns an optically clear oil with reduced acidity and odor. The use of an earth filter entails loss of oil due to an absorption. There is no convention method for recovering the earth, which costs from 2 to 5 cents a pound. Oil is filtered while hot and sometimes under a pressure of one of two atmospheres. The proportion of earth to oil is about 1 lb to the gallon or approximately 1 | 9 by weight. There may be considerable variation from this figure, depending upon the amount of sludge which is carried through the first part of the process and deposited an an impervious coating on the filter cake. The cost of removing dirt by this method is comparatively high, but the results are good.

Some machines run the oil through cotton waste, or prepared asbestos pads several inches thick. There is on the market at the present time a form of asbestos that can be mixed with the oil and allowed to form its own cake as the oil runs through a suitable screen. The cake is evenly deposited less than ½ in thick and is sufficiently elastic to avoid cracking. This latter method returns an optically clear oil whose color is partially restored. Since the cake is thin, almost no oil is lost. The best results are obtained from this method when the oil has first been washed. The product may be optically clear but dark in color.

A third method of eliminating extraneous matter from the drainage is washing and settling, sometimes combined with quick filtering. This method uses trisodium phosphate, sodium silicate, or some patented washing powder. Washing is generally carried on at a temperature of 200 deg. F., sometimes obtained by the direct introduction of live steam which not only maintains the temperature but also aids in the agitation. A new type of reclaimer uses this method, followed by a long period of settling. The oil is then floated off, and the process stopped as soon as any sediment appears. This machine has been in operation for a two-year trial period, and is said to give excellent results at a low cost.

Whatever methods are employed for cleaning, the result should be an optically clear, brilliant oil, regardless of color, and tests should show it to be free from any filtering material or clearing substance. If it is decided that a dark oil is permissible, centrifuging, washing, filtering through asbestos or other substances, will give good results. For a light colored oil the various clay and earth treatments will have to be used.

The cost of reclaimers based on capacity lies between $4.50 and $16 per gallon of finished oil. Capacities vary up to 200 gal. per 24 hours, and prices from about $600 to $3,000. The net cost of reclaimed oil varies from 3c. or 4c a gallon to as high as 22 or 23 cents—lower figures being reported from the south and southwest. Fifteen per cent is the average reclaimer loss, depending upon the type of machine used and the amount of diluent to be removed. For aviation oil, the loss due to reclamation is more than it should be because wastage occurs chiefly in absorption of oil by the filtering process, and not in evaporation of the diluent. There is also a saving not immediately apparent in the reduction of new oil inventory not only in money invested but also in space freed which may be valuable for other purposes.

Testing reclaimed oils

There are two methods of testing reclaimed oil. The first is the very practical way of making a test run in service under known conditions, and comparing with results obtained from a similar run using new oil only. This system offers almost unsurmountable difficulties, however, as there is little or no assurance that test conditions will be identical, and that the results may be misleading. The second, and safer method, lies in a combination of direct comparison testing and laboratory analysis. An ideal set-up for this sort of test would be a complete lubrication record showing (1) the amount of lubricant used against miles flown, (2) the repair bills on engines (charted from month to month, to show failure of an engine part due to poor lubrication), and (3) records of analyses of the reclaimed oil. This should afford sufficient data to determine the amount of money saved, directly and indirectly, and would continually check the annual efficiency of the system.

Suggested laboratory tests follow. These tests may be used for new or reclaimed oil and can therefore be used as a basis of comparison.

1 Gravity A.P.I. The A.P.I. scale is standard for the petroleum industry. The reading should coincide with, or be very close to, the gravity of new oil.

2 Viscosity—Saybolt universal. This is reported as so many seconds at 100, 130, and 210 deg. F. Different temperatures are specified because at any one temperature the viscosity curve might coincide exactly with that of the new oil but be considerably off at some other temperature, which might be critical for the conditions under which the oil is used. It is recommended as good practice to restore the oil viscosity as nearly as possible, within 2 or 3 per cent.

3 Flash and Fire—Cleveland open cup. Here the difference between reclaimed oil and new oil might show up as much as 30 or 40 deg. deg. F. or more. If it tallies with the new so much the better, but it may read low on account of the heavy ends of the fuel which are sometimes left in to prevent excessive viscosity. A slight amount of diluent has an effect on the flash point, but the flash and fire points should not show a marked tendency to approach each other.

4 Conradson carbon residue test. This test will probably yield lower values for reclaimed oil than for new oil, but is to the advantage of the reclaimed oil, as it is an index of the tendency of the oil to form carbon. The residue contains road dust and silica, metal, and carbon which may be analyzed and the percentage of each shown.

5 Acidity. Acidity may be given in terms of oleic acid by per cent volume, or it may be given as the neutralization number, or the number of milligrams of potassium hydroxide to neutralize one gram of oil.

6 Pour test. This test indicates the lowest temperature (deg. F.) at which the oil will flow. The figure should be as low as that for new oil. If it is much lower note the diluent content.

7 Water or moisture control. In an airplane engine with rapid oil circulation, water would not be expected to give much trouble. If it is found the reclaimer must be run at a temperature high enough to drive off the water. The figure should be as low, or lower as that for new oil.

8. Diluent. This is reported as per cent by volume and may exceed the new oil figure.

Comparison of new and reclaimed oil used at the Wright Aeronautical Corporation (DeLaval)

	New Oil	Reclaimed
Specified gravity (at 60 deg. F.)	911	9115
Baume (at 60 deg. F.)	23.7	23.6
Flash point (deg. F.)	476	470
Burning point (deg. F.)	519	520
Four test (deg. F.)	37	37
Water	Nil	Trace
Carbon residue (per cent)	1.40	1.55
Ash (per cent)	.10	.02
Acidity	Nil	Nil
Alkalinity	Nil	Nil
Per cent distilled up to 410 deg. F.	3	3
Per cent distilled 410-572 deg. F.	12	0
Viscosity saybolt at 210 deg. F. (sec.)	110	107

Aviation enters the merchandising era

By B. D. DeWeese

General Manager, Stinson Aircraft Corporation

AVIATION is as old as the automobile business if we measure the first flight of the Wright Brothers against the advent of the gasoline buggies of Haynes and Olds; yet its progress has been slow when compared to that industry. Some 7,000 airplanes are in use against some 25,000,000 automobiles.

Much of this difference in progress can be attributed to the fact that engineers have dominated the aviation business, while salesmen have held the upper-hand in the automobile industry.

We all must admit one other drawback—it requires more skill to fly a plane well than it does to drive a motor car. The difference is not as great as the production figures indicate however, as there are some 17,000 licensed pilots in the country, and some 5,000 more are being taught to fly each year; therefore we cannot put full blame of the backwardness of our industry on any dearth of flyers. Neither can we blame the weather, as many airlines are now flying more than 90 per cent of their year 'round schedules, and individuals are piling up time every day.

During this same period our industry was "stunting" and trying to demonstrate its ability to fly upside-down. Thousands of people would drive hundreds of miles in their automobiles to see our "circuses." We mentioned *thrills* in a husky voice, but did not try to sell these people on the value of our planes as a transportation utility or tell them about the pleasure and fun of flying up in the wide open spaces.

Nowadays we are telling the folks about *speed* and *more speed* and forgetting for the moment that the greatest deterrent to flying is *fear*. Why not talk about strong planes, comfortable planes, quiet planes, radio beacons, smooth landing fields and other features which apply to present-day flying.

But—our opportunity has come—those 25,000,000 automobiles have caused a traffic problem. The Sunday ride is not the fun it used to be, as too many want to frolic on those available grassy spots. The roads are full of automobiles and you can't get anywhere any more. Yes, truly, here's our chance. Will we step in on this situation and sell our wares? Our engineers have done a *good* job. Our production men are learning how to get the costs down and build trouble-free planes at low prices, but *what about selling?*

Where are the aviation merchandisers? We may have a few individual stars, but where is the group effort coming from? This group selling is vital if we are to create the desire to own an airplane in the minds of a portion of these millions of people who drive good automobiles, motor boats, etc.

Mr. Lindbergh has contributed more to individual flying than any other man, and now is helping family flying; but the industry as a whole cannot expect a few individuals to do it all. Who will be the Nashes, Jordans, Grahams and Faulkners of our industry?

The Ludingtons and the E. L. Cord airline interests are helping with low rates which greatly increased group flying on all airlines and many claim that this will convert tens of thousands to flying as individuals; but this is too slow. We must get quicker action by group effort.

Only the mossbacks will disagree with the fact that our industry has entered the merchandising era. Only those companies who realize this fact and act upon it will prosper, as subsidies must wane and sooner or later all of us will be called upon to stand on our own feet.

Speed planes of 1931

The quest of speed forces refinement in plane and engine design but indicates a wide variety in individual appearance of airplanes. The machines which figured in the Thompson Trophy Race and the Schneider Trophy Contest represent a broad range of types and their salient features are discussed in this article

THE National Air Races in this country and the Schneider Trophy Contest in England have brought into the limelight the most successful and novel racing planes produced in 1931. The machines at Cleveland set up new transcontinental and Thompson Trophy records, while the Supermarine-S 6B made several F.A.I. records in addition to a new mark for the Schneider. The American landplanes represent the fastest non-military machines of recent production anywhere and their innovations represent important steps in design.

Planes prominent in the field of high speed include the Gee Bee Super Sportster produced by Granville Brothers Aircraft, Inc., Springfield, Mass., of which Robert L. Hall is chief engineer; the Solution II, E. M. Laird Company, of Chicago, the We-Will, Wedell-Williams Air Service, Inc., New Orleans; the San Franciscan, built by Keith Ryder under auspices of the San Francisco Air Race Association; and the Vickers-Supermarine-Rolls Royce product, designated as the S 6B, that won the Schneider.

It is particularly noteworthy that all the American racing planes are air-cooled, a practice made possible by the introduction and refinement of N.A.C.A. engine cowls. Streamlining of the undercarriage, most effective enemy of power from constantly improved engines, has been the object of much contemporary attention and of further research for this year's grist of racers. Most conspicuous is the success with reduction of cockpit drag on two machines and the unusual close coupling achieved in the Gee Bee Super Sportster.

Supercharging

The quest for increased speed has in recent years centered chiefly around problems of cleaner air plane design, but has been extended to include the engine as well as the plane. The result is that the Gee Bee, Wedell-Williams, and Laird racers are powered by the Wasp Junior, supercharged from 300 to about 525 hp. (some 100 hp. more than the Senior Wasp), which weighs only 560 lb. as compared with 775 lb. for the Wasp Senior.

Though we have scored successes in the development of land racing planes in this country, we have done nothing in recent years with fast seaplanes. Something in this category may be expected from the $200,000 research fund available to the Navy for high speed experiments. In the meantime, world honors go without reserve to the British who in 1929 produced the Supermarine S 6 to achieve a world speed record of 357 m.p.h. and in about six months this year refined that type in model S 6B to push the mark up to 408.8 m.p.h.

One engine was used for the Schneider race and another, called a "sprint" engine, for the high speed record. The former developed 2,300 hp. and the latter 2,600 hp. In designing these power plants it was intended that they should be able to run at full throttle for at least an hour. By the end of April the experimental engines would usually last only about twenty minutes before a failure occurred. By the middle of July the engines could be run only 30 minutes without a breakdown. An hour's run was not achieved until Aug. 12.

Reducing cockpit drag

In their efforts to reduce drag, designers of at least two American machines have introduced extreme methods of housing the pilot. The Gee Bee cockpit is faired into the vertical stabilizer and becomes almost a part of that member. The pilot is completely enclosed, his head being surrounded by a "half-dome" windshield and by the high turtle deck fairing which merges with the fin.

The cockpit of the Laird Solution II is in about the same relative position in the fuselage as is that of the Gee Bee—about three-fifths of the distance from the nose to the tail—but is faired into the trailing edge of the upper wing, the turtle-deck behind the pilot's head sloping downward so that the vertical stabilizer is distinct and conventional. The Laird cockpit is enclosed by three units. There are two side cowls which are hinged at the top longeron and when closed join with the trailing edge of the wing on which are a pair of guides carrying the windshield. When the windshield is slid back into the closed position it automatically locks the side cowls and makes an unbroken line along the top of the turtle deck.

This presents practically no frontal area, while the Gee Bee "dome" protrudes about 8 in. into the slipstream. By the same token the latter provides slightly better visibility ahead than the former. Visibility from both machines is greatly impaired by the wide noses and flat fuselages. So limited is the vision from the Laird that Doolittle flew several miles to the right of the markers along the federal airway in navigating his way east for the new transcontinental record, and flew each lap of the Thompson blind except for side views and the mental picture he would get of the next leg as he rounded each pylon in turn.

In contrast to these two, the cockpit of the Wedell-Williams racer reflects very little streamlining effort. The windshield is conventional, rises several inches above the fuselage and is wide. The turtle deck back of the cockpit is as high and wide as the windshield, and fairs away to a conventional set of tail surfaces.

It is interesting that the same highly developed streamlining which characterizes the British Schneider machines has not been applied to the cockpit arrangements. The windshield does not enclose the pilot's head completely, though it does conform to the turtledeck fairing from engine cowl to tail. In fact the windshield is but a transparent portion of that fairing, hinged at the forward edge for opening upward and forward. Since the fuselage is narrower than those of the American machines (because of the water-cooled engine) and since the fuselage is longer, the range of vision is much greater, particularly as it is possible for the pilot to extend his head beyond the cockpit rim by virtue of the U-shaped opening. The cockpit and windshield design on the San Franciscan resembles closely the Supermarine type.

Streamlining of the Gee Bee fuselage involved much careful moulding to produce its extreme form. Wood bulkheads covered with hammered aluminum fillets are clamped to the forward sections of the fuselage and serve to build up the wing stubs to a streamline section. Rearward from the front of the cockpit, fairing strips were generously employed to produce the characteristic fuselage shape and fair it into the tail surfaces. Chrome molybdenum steel was used in fuselage and tail structure.

The Laird fuselage is constructed of duralumin tubing joined with steel sleeve fittings and trussed with tie-rods. The Wedell-Williams fuselage was built of chrome-molybdenum steel and steel wires. All welding was done by J. R. Wedell himself. A metal monocoque fuselage, oval in cross-section, was adopted for the San Franciscan. The fuselage of the S 6B likewise is of metal, with the metal skin so designed as to take practically all the stresses.

The general design characteristics of three prominent racing planes. Left: the Wasp powered Laird Solution II. Right: the Supermarine-Vickers-Rolls Royce S 6B. Below: the Wasp Gee Bee Super Sportster

Undercarriages

Undercarriages have always been the source of more parasitic drag than any other unit of the airplane, a matter of particular concern in the racing plane. Notable advances in the reduction of their resistances have accompanied the demand for more speed, as it became evident that smoothing up of the airplane's surfaces in the light of increased aerodynamical knowledge contributed improvements in performance commensurate with the addition of horsepower to the engines. Better streamlining of the undercarriage parts, including use of retractable and cowled

Comparative specifications of five speed planes

Plane and Engine	Span (Ft.-In.)	Chord (In.)	Length (Ft.-In.)	Weight Empty (Lb.)	Gross Weight (Lb.)	Wing Loading (Lb. per Sq. Ft.)	Power Loading (Lb. per Hp.)	High Speed*	Wing Area (Sq. Ft.)
Gee Bee, Wasp Junior, 535 hp.	23-6	50 4	15-1	1 400	2,200	30 20	4 26	269	75
Laird, Wasp Junior, 535 hp.	21 0	42 0	19-6	1 560	2,402	22 16	4 68	258	112
San Franciscan, Menasco 260 hp.	23-4	60 0	17-6	800	942	14 50	3 60	200	65
Wedell-Williams, Wasp Junior, 535 hp.	26-0	60 0	21-0	—	—	—	—	255	
S.6B, Rolls-Royce R, 2,360 hp.	30-0	66 2	27-9	4,050	5,995	41 30	2 60	408 8	145

*Approximate in some cases. Estimated from best data available.

landing gear assemblies, is a distinct feature of the 1931 models

The undercarriage of the Gee Bee has a tread of 5 ft 11½ in. The wheel and strut assemblies constitute two legs, each about 4 ft long and extending downward vertically from the center section stub, as viewed from the front. Each leg is enclosed except for a small cutaway between the struts close to the wing. The three main struts are roughly in the shape of the letter N, attached to the center section wing stub at the upper end and carrying a pair of wheel forks at the lower end. The forward leg of each N incorporates an oleo shock absorber. The legs are wire braced to the center line of the fuselage and to points on the wing about two thirds of the distance from the fuselage to the tips.

The undercarriage of the Solution 11 differs widely. The wheel tread is much narrower, being only 4 ft. 5 in. wide, and the struts extend to the wheels diagonally from the bottom longerons. The forward members are in the form of a Y with each strut incorporating two Cleveland Pneumatic shock absorber units. Struts and wheels are completely faired in. There is a single streamline wire between the two legs above the wheels and flying wires to the top of each wing strut.

The Wedell-Williams undercarriage differs from either of the foregoing. It consists of two independent and entirely cowled legs; the forward strut in each is a heavy tube running from the upper longeron to the short axle and the drag strut runs from the lower longeron to the axle. Each axle is at right angles to the struts and extends outward far enough to permit clearance for the wheel cowls. The undercarriage is wire braced one wire connecting the two wheel hubs in place of a solid axle.

The San Franciscan has a folding undercarriage which includes a number of new features. There are two stiff struts attached at the upper ends to the center section stubs and extending to the outer ends of the axle are only slight forward and outward angles. Two bracing struts extend from points about 1 ft. from each end of the axle to points on the longerons about half the depth of the chord. It is equipped with air wheels. There is also wire bracing from the ends of the axle to the center line of the fuselage on the same plane with the forward struts.

When retracted the wheels fit only partly into recesses in the bottom of the wings. A unique connection between the gear and the stabilizer automatically adjusts the latter to compensate for changes in position of the wheels. The axle does not allow much clearance of surface obstructions and the forward bracing members have to take the major shock of landing. The wheel tread is 3 ft. 6 in.

While streamline struts are used in the S 6B machines, there is no attempt to enclose forward and rear members because of the distance between them. The floats are wire braced fore and aft and across and to points on the wing. Into the pontoons are built the steel fuel tanks and along their entire upper surface are water cooling radiators, insulated from the fuel tanks to prevent gasoline evaporation. The starboard float carries more fuel than the port to compensate for the engine torque, which at full throttle has the effect of transferring 500 lb. of fuel from one float to the other. It was necessary also to provide an elastic framework for this float radiator system to prevent its buckling when full of hot water. These floats also have improved aerodynamic characteristics over previous S models. They are almost as long as the planes themselves measuring 27 ft. 1½ in.

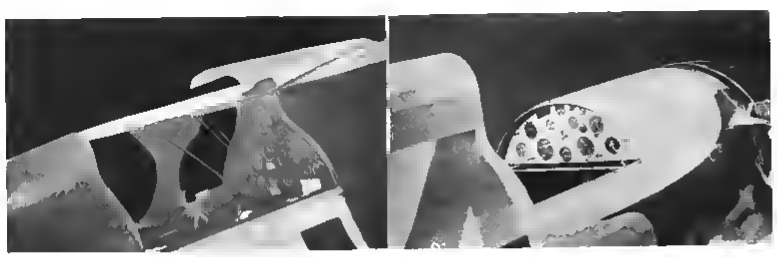
The cockpit and windshield of the San Franciscan

Engine installations

The American racing planes have air-cooled power plants, calling, of course, for careful cowling to reduce frontal resistance. The Gee Bee, Laird, and Wedell-Williams machines are powered with the special radial Wasp Junior, and are equipped with full N.A.C.A. cowls, slightly modified. That on the Wedell-Williams appeared to have been modified more than the others, having slight bulges near the forward rim to accommodate engine projections. Streamlining of the San Franciscan and the Howard was slightly increased and internal reconstruction of the oil cooling system increased its effectiveness about 40 per cent, without adding to the external area of the fuselage. All the high speed machines have metal propellers.

Contemporary popularity of air-cooled engines in American racing planes is due to the simplicity of installation and maintenance as compared with the highly delicate system of water and oil cooling attending a water-cooled unit. An extreme example of the difficulties the latter involve is afforded by the British Schneider machines. The exterior of the S 6B is composed almost entirely of radiating surfaces. The wing skin is composed of water radiators, into the sides of the fuselage have been built pipes for cooling oil, while even the vertical stabilizer is an oil cooler. And, as mentioned above, the tops of the floats also include water radiators. There is plenty of opportunity for malfunctioning of such a complicated array.

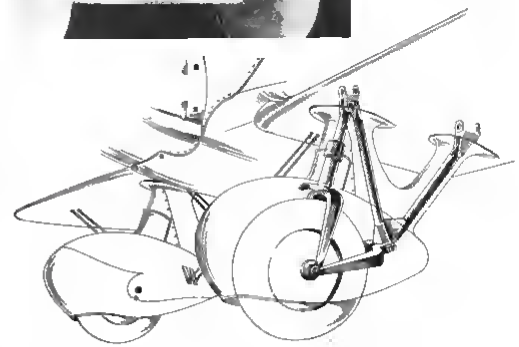
However, air-cooled racing power plants have been practical only in the few years since the introduction of effective cowling, and even with the best cowl design their streamlining has not been refined to the degree possible with water cooled installations. Though at present not prominent for racing in this country, water-cooled engines would be the only possible type for competition in anything of the Schneider class.



The cockpits of the Laird Solution 11 (left) and the Gee Bee (right), showing the windshield arrangement of the former

It was necessary this year to increase the area of the cooling surfaces so that the higher powered Rolls Royce R engine, the 1929 model of which was run at reduced throttle on account of the tendency of the engine to heat up, might be flown at full throttle with safety. The area of the wing was slightly increased and internal reconstruction of the oil cooling system increased its effectiveness about 40 per cent, without adding to the external area of the fuselage. All the high speed machines have metal propellers.

Two interesting under carriages. (left) the folding San Franciscan unit. Below the detail of the Gee Bee landing gear



Wing areas

The Laird is the only biplane in the group. All wings are tapered the most extreme being those of the Gee Bee, which taper off quite sharply from a point on the trailing edge about two thirds the distance from the fuselage to the tip, and those on the San Franciscan, which have a chord of 5 ft. at the root and 2 ft. near the tip. The Gee Bee wing has an angle of incidence of 3 deg. and dihedral of 4.5 deg., while those on the other machines have very small angles of incidence and virtually no dihedral.

Wings on the Gee Bee, Laird, Wedell-Williams and San Franciscan are built up of wood spars and ribs in conventional manner. The first two are fabric covered; the Wedell Williams wing has a very thin section (modified N.A.C.A. M-10) and is plywood covered to provide additional strength. Plywood is used also on the San Franciscan, which has an M-6 section. The S 6B wing is metal inside and out, the radiator skin being designed to take the torsional loads. This radiator is made of two thin sheets of duralumin, spaced with thin strips of the same material to provide area for the circulation of water. Unlike the corrugated wing radiators used in earlier American racing machines, the English type has a smooth outer surface which offers no more friction than a cover of fabric.

External bracing of the wings in all cases is of the conventional form with streamline wires. On the Gee Bee the wires run through the wheel cowl in which openings have been cut to permit a 4-in. travel and are connected with the heel of the undercarriage. The Wedell Williams machine has more wires than the Gee Bee, some of them being connected with the wheel hubs. The Laird has the typical broad Laird strut between the upper and lower wings and ailerons are attached only to the lower wing. Ailerons of the 1931 machines on the whole are conventional, though those of the San Franciscan are notable for being covered with corrugated duralumin.

Although the S 6B is 745 lb. heavier than the S 6 of 1929, the wing span, chord and area are the same. Additional lift was secured by re-setting the angle between the floats and wings and by careful re-designing of the floats. The floats are longer than before but the drag per unit area has been decreased.

The most unique aspect of the Gee Bee from the designer's standpoint is the close coupling, which has been achieved in the face of former almost universal skepticism of its practicability. Earlier attempts in this direction have usually resulted in serious difficulties with stability and control. The overall length of 15 ft. 1 in. is but 60 per cent of the span, a very unusual relation in a monoplane, the diameter of the propeller—8 ft. 2 in.—is more than half the length. Tail surfaces are but little larger in proportion to the wings than is standard practice with much longer fuselages. Horizontal tail surface area is 20 per cent of the wing area. The stabilizer comprises 8.4 sq.ft., the elevator 6.95 sq.ft., the fin 2.2 sq.ft., the rudder 4.9 sq.ft. The rudder is high and narrow and has a curve suggesting a battleship stern. The rudder of the Laird is wider in proportion to its height, that of the Wedell Williams even more so and that of the San Franciscan also suggests the battleship stern.

The most unusual fin is that of the Gee Bee, on which the fuselage has been merged, as previously stated, with an extreme form of cockpit fairing. The top of the fin is only about 6 in. above the top of the turtle deck. Elevator and stabilizer surfaces are quite conventional on these planes, though the elevator of the Gee Bee is notable for its relatively high aspect ratio.

Tail flutter developed on the S 6B during one of the early test flights by Squadron Leader Orlebar, who avoided a serious accident by making an immediate landing far from the Calshot base. Mass balances on ailerons and rudders were introduced to correct this tendency. They are small streamline weights carried on arms extending in front of the hinges of the control surfaces.

Another difficulty was the tendency of the machines to "hunt," that is to be unstable longitudinally at extremes of the speed range. The planes were found to be exceptionally sensitive to minute changes in the position of center of gravity, to obtain the most favorable center of gravity position it was necessary to reduce weight aft. Since this condition became evident only in the latter periods of training, R. J. Mitchell, the designer, effected a change in weight distribution by substituting fabric covered rudders for the original metal ones.

Trimming the machines to fly without undue pressure on stick or rudder was another problem. Since alterations in the angle of incidence in the tail plane so small as to be immeasurable had a powerful effect on the trim, narrow metal strips were attached to the trailing edge of rudder and elevator, and by bending them the plane could be trimmed with accuracy.

Boeing's system for schooling flying personnel

Selecting and training transport pilots

By H. T. Lewis
Chief Pilot, Boeing Air Transport
and George I. Meyers
Chief Pilot, Boeing School of Aeronautics

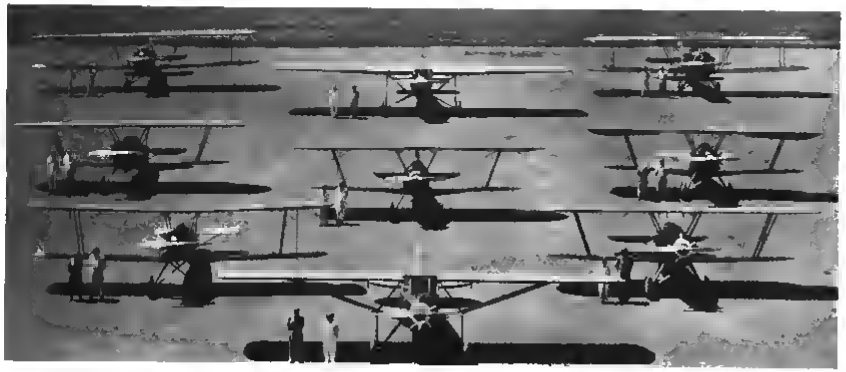
PILOTS who are to be trusted with valuable equipment and who must conform to strict flying schedules with mail and passengers must be scrutinized carefully before employment. Since heavy labor turn-over is costly to the operating company and demoralizing to personnel, Boeing Air Transport has employed few new pilots, recruiting its flyers from co-pilots who have been appointed only after they have demonstrated abilities to handle their jobs efficiently and to cooperate with their fellow employees.

All co-pilots now being employed are recruited from the Boeing School of Aeronautics, a subsidiary. It has sometimes happened that a co-pilot with 1,000 or 1,200 hours flying time in some other organization to his credit, is apt to think he knows more than the regular pilots. He is not satisfied to remain a co-pilot longer than a few months, and starts asking for a regular pilot's job, which causes dissension and friction. It has proved to be a better policy to take young pilots from the school and train them with the line personnel. By the time they have had about 1,500 hours as co-pilots they are well worked into the organization and know all the rules and regulations, whereas a new man coming in does not have all this information and does not adapt himself so readily.

After approximately 1,200 hours an able co-pilot is considered for a reserve pilot position, to fill any vacancy which may occur. Such a position carries the same responsibility as a regular pilot. The line now employs 41 regular pilots and thirteen co-pilots. Seven of these latter were taken from the Boeing School, the remaining six having been employed before the school had students available to fill the positions.

Young pilots preferred

Pilots around the ages of 20 to 22 are the most desirable from a standpoint of employment tournover, and an age limit of 30 years has been set for hiring co-pilots. This limit is placed as younger men have more adaptability for training along the lines desired and because three or four years are required for a co-pilot to qualify himself for a reserve flying position. The younger



Several types of planes are used in the Boeing School of Aeronautics in teaching students—future transport pilots—to fly

the pilot at the beginning the longer flying service can be expected of him and consequently less turnover in pilot personnel.

Forty years is usually considered the limit of age usefulness of an air mail pilot, although there are three men now flying on the line who have passed this limit. Some of the best pilots are in the neighborhood of 36 years of age. This does not mean that their age is the cause of their excellence, but rather the long years of experience while flying the air mail in encountering and surmounting all kinds of bad weather obstacles. It is found, however, that younger men usually make the best pilots because of their greater vigor and quickness of response.

In 1929 the inauguration of a double schedule necessitated the employment of several new men to augment the old air mail group which had continued with B.A.T. after the Post Office relinquished the job of flying the mail. Most of the new pilots were obtained from the Army and Navy, and a few from various civilian routes. With the beginning of tri-engine service which required the use of two pilots on each transport, it was necessary to employ a number of co-pilots, but since the first students graduated from the school the transport division has called on the former for its requirements of co-pilots as the need has arisen.

George I. Meyers, above left, and H. T. Lewis

Although the co-pilots furnished by the school to the transport service have not been in service long enough to draw many conclusive comparisons, it is apparent that they are better than the average non-technically-trained co-pilots taken from other sources, even when compared with men who have had up to 2,500 hours flying experience. They have a knowledge of navigation, (which few of the older pilots have taken into consideration), and second, they have complete information on the latest development and usage of instruments, (which fewer of the older pilots rely upon). It is essential that a pilot have the latest knowledge of instrument flying in order that he may use that knowledge in emergencies.

While the co-pilot naturally cannot be expected to assume the duties of a pilot without further training the normally competent flying student should be able to handle tri-engined planes, solo, after approximately 100 hours as co-pilot. Senior pilots give co-pilots instructions and assistance in flying these planes and after a time the latter is permitted to fly them to further his own experience. When clear weather prevails the senior pilot generally permits the co-pilot to do most of the flying with some landings and take-offs. In fact, most co-pilots fly more than the regular pilot. They fly longer owing to the fact that they have no particular responsibility and are under no great strain.

A broad training

Present day transport pilots can hardly be compared in training and technique with those of ten or fifteen years ago. At that time the aim in training was to give the student sufficient instruction to permit him to get off the ground and back again without damaging the plane or himself. After he had reached that degree of proficiency, a few stunts and several difficult maneuvers were given and the student proceeded to advance on his own. To meet the requirements of today's transport companies, he must have many hours of advanced training in handling his plane in a smooth, easy and safe manner, and, in addition, he must be schooled to fit into a highly specialized commercial organization. In the early days a student pilot did not have in view the prospect of affiliating himself with some large transport company. All he could look forward to were short passenger hops, cross country flights, or circus performances at fairs.

In order to give present student pilots as broad training as possible up to the point of receiving their transport licenses, they must have experience in flying different types as well as planes of various weight, power and speed. They must be able not only to take a plane off the ground and land it again, but also be able to take a cross-country trip, lay out the course and fly by instruments. They must have experience in flying at night. The latter requirements are becoming more and more important.

The course in the Boeing School of Aeronautics is laid out to give as varied a training as possible in several types of airplanes. In a small open plane the student is taught to perform all the maneuvers of flying, such as vertical turns, gentle, medium and steep "eights" spins, wingovers and side slips. He must perfect himself in these maneuvers to the point where he is smooth and positive on the controls and always sure of his position with reference to the ground. He is then required to make left and right spins of two turns each and to come out within one-eighth to one-fourth turn of the desired point. Thorough training is given in how to handle a plane in case of a forced landing, and in getting into small fields. The student must also learn how to read the instruments and to place trust in them instead of in his own reactions. This is accomplished through instrument flying in a hooded cockpit. In addition to handling the controls, the embryo must know whether his engines and plane are functioning perfectly and must be able to make minor repairs in case of a forced landing away from an airport. He must be able to navigate, have an understanding of meterology, and know how to operate and make minor adjustments on radio equipment. In addition to this training he is given time on both large and small cabin planes, and on Boeing mail planes. From the beginning, the student is instructed how to take care of equipment placed in his care. He is taught to realize that an engine and plane are mechanical devices which if pushed to its limit will not give the best service. Never during the course is the student led to think that the training given him will place him in a class to compete immediately and without further experience with old air mail or transport fliers.

The personal relationship of the prospective pilot to his employer and fellow worker cannot be over-emphasized. He is taught in the school to realize he is a personal representative of any company for which he may be working. His general apperance, his attitude toward his duties, his cooperation with his fellow workers are noticed by the public and creates the impression by which the organization is judged. Thus the pilot's appearance and his ability to cooperate with others are not the least important attributes going to make for his success.

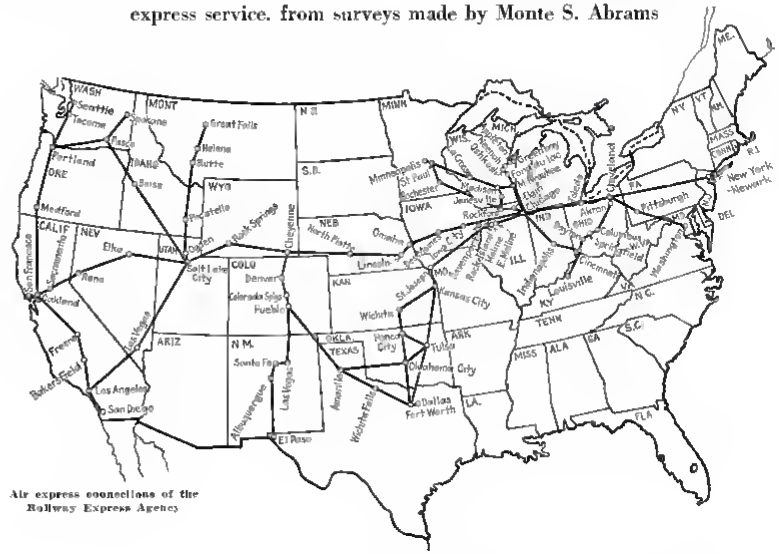
AVIATION moves to new offices

AN INVITATION is extended to our readers to visit our new editorial offices on the 28th floor of the recently completed McGraw-Hill Building at 330 West 42d Street, New York. This 33-story edifice is unique in that it is the largest structure in color in the world and is readily distinguishable because of its wide horizontal bands of blue-green terra-cotta blocks at each floor level. The plans were drawn by Raymond Hood, who designed the News Building in New York, the Tribune Tower, Chicago, and has been prominently identified with the architectural development of Radio City, New York, and chief architectural consultant for the Chicago World's Fair.

Concentrated in this new home, less than five minutes' walk from Times Square, will be the headquarters of, not AVIATION alone, but 33 other McGraw-Hill Publications, the McGraw-Hill Book Company and three more affiliated companies. In addition to the benefits to be derived from this close association of McGraw-Hill units, our editors will be able to cooperate more closely with the various engineering societies through the use of a large auditorium provided specifically for the purpose. The move is scheduled for late October, and we shall be at home after Nov. 1.

The south side of the new McGraw-Hill Building, 330 West 42d Street, between 8th and 9th Avenues, New York City. AVIATION'S offices are grouped about the corner facing the camera on the 28th floor (the second below the topmost setback). The floors below include departments devoted to the production and service work of AVIATION and other McGraw-Hill publications.

Some of the problems which have confronted local operators in their efforts to develop express service, from surveys made by Monte S. Abrams



Air express connections of the Railway Express Agency

Perplexities of air express

IN SPITE of the optimistic prediction of those enthusiasts who are convinced that the near future will see all classes of commodities from carpet tacks to soft coal being transported by air, shippers today show very little tendency to make extensive use of the air express facilities which have already been established. During the first six months of 1931, the Department of Commerce reports a total movement of domestic express matter of 1,129,976 lb. In this total are included the operations of the Ford Motor Company, which is purely a private express venture and does not represent in any way public support of established air express lines. Their total of 882,551 lb. when subtracted from the amount reported for the country at large leaves only 247,425 lb. moved by regularly organized companies. This figure must be further reduced to make allowance for the multiple reporting of shipments to the Department of Commerce. Their total figures are obtained by adding up the poundage reported carried by each individual airline,—thus certain shipments moving from New York to Los Angeles may enter the total three times one credited from New York to Chicago, one for the Chicago-San Francisco run, and one for the move between San Francisco and Los Angeles. Not having available the details of each individual shipment, it is impossible to evaluate accurately the exact total weight carried, but taking into account the possible number of double and triple entries, it is not unreasonable to suspect that the figure remaining after deducting Mr. Ford's shipments, should be reduced by at least 20 per cent. On this basis it is quite probable that not over 200,000 lb. of express matter moved by air between January and June of the current year. During the same period, the air mail operators recorded a total weight carried of 4,332,714 lb.

There is little doubt but that the question of rates has been one of the greatest retarding factors in the development of air express. Under present conditions there is no way to get around the fact that it costs more to transport goods by air than it does by any other known means of carriage. To be sure, speed of transport is very much higher by air, but it is an open question as to what proportion of goods that are shipped by express today are sufficiently enhanced in value at their destination due to early arrival to bear the increase in transportation cost. Even the most optimistic exponents of air transportation do not foresee rates much lower than three times the rates for the same trip by rail express. On this basis, there is a wide divergence of opinion as to how much of the present traffic should go into the air without having all the profits swallowed up by the unusually high rate differential. Certain individuals do not hesitate in saying that 5 per cent of the present

traffic would easily be diverted into the air if proper facilities were provided Others are equally certain that not over one-tenth of this amount could possibly stand the increase in transportation costs Undoubtedly there will always be a certain class of goods, which, by reason of emergency, must be moved quickly regardless of cost Such items undoubtedly constitute the bulk of air shipments today, but there is little reason to suspect that this class of goods will ever be available in sufficient volume to afford a basis for a nation-wide express shipment The other major class of shipments which now go forward by air are those of the publicity seekers. Merchants and manufacturers are perfectly willing to spend a little extra money to ship some of their products by air, provided the company name appears in large letters on the shipping carton, and that a photographer is on hand to record the loading of the airplane. Very rarely is there any excuse but publicity for shipping bicycles or sewing machines to the West Coast by air This type of business is obviously of a very transitory nature, and cannot be depended upon to furnish a background for substantial aerial express shipments Undoubtedly there are classes of goods which, as rates come down, will find a legitimate place in the transportation picture, but it will require considerable development to bring them to the fore

Difficulties to overcome

Aside from the question of rates, there are numerous other factors which must be worked out before air express passes out of its infancy Certain independent operators particularly on the West Coast have concentrated on the development of air express, and most of the large operators have catered to express traffic to some extent, but the small specialized express operators have failed miserably in almost every case, and the large operators have not succeeded in developing any appreciable volume of air express. There are a number of difficulties which have come to light from the work which has been done so far which must be corrected before a satisfactory volume of traffic can be developed

Aside from the question of rates the lack of nation-wide, coordinated air express facilities have tended to retard the development at the present time So far the attempts to develop traffic have been conducted independently by a great many individual operators, few of whom have had direct connections with other organizations There has never been any general set of rules for handling air express, any coordinated scale of rates, or any general agreement on the handling of packages between the various airlines and the country has been a hodge podge of individual operations This leaves the average shipping department in a quandary as to which points can be reached by air express and what the rates may be to various points over different airlines. Until shipping clerks can toss all air express packages into a single bin and have them handled from then on by a single service, whether they go to Podunk, Iowa, or to Oskeewowee, Me, there is likely to be comparatively little general use of air express facilities. In the meantime air express loads are coming largely from those who are faced with real emergencies, or who happen to be regularly shipping over a route that is directly served by air express operations

A unified system

It is only logical that air express service should be rendered by a single organization, similar to the rail express service, reaching all towns of importance and providing a single system in each town for the pick-up and delivery of loads, the collection of accounts, tracing of shipments, handling bills of lading and other details Obviously a universal service of this sort cannot be provided until a sufficiently large number of air lines cooperate to set up a single air express handling organization of nation-wide scope with a uniform set of handling and operating regulations, and a standard scale of rates.

An effort toward standardization and unification is now being made by the Railway Express Agency which has contracted with certain operators to handle express matter on planes This work is still in the development stage, but the services are already available between a number of important centers as the accompanying map indicates, and will probably be extended if the demand for air express facilities increases

One factor that has handicapped greatly the development of air express traffic has been that such operations have been conducted for the most part by individuals or organizations with little knowledge of express handling methods In general, their approach has been wrong in that they have concentrated on the problems of carrying the loads by air, whereas the real problem is in the setting up and operation of adequate handling and contact facilities on the ground. A number of ill-advised local operations have failed because their sponsors were primarily air men who, intrigued with the possibilities of operating planes at low cost with freight loads, neglected to give proper consideration to methods of building up and properly handling the ground end of the business Until air express operations in this country are organized and directed by men who know express and package handling intimately this phase of air transport will not measure up to its possibilities Difficult as are the problems of carrying heavy loads by air, the real problems that confront the development of air express are those of seeking out legitimate traffic, controlling it so that a relatively uniform flow will result, and handling it on the ground with sufficient efficiency and economy to satisfy the shipper and to make it possible for the operator to realize a profit

The most vital of the operating problems connected with handling air express traffic, that of ground handling at terminal cities, has been attacked in three ways to date, none of which have been wholly satisfactory. The ground handling system of the Railway Express Agency has sometimes been employed for the handling of air express, some operators have organized various ground handling schemes of their own and recently the messenger services of the Western Union and Postal Telegraph companies have been linked with the air express operations of various air transport companies' lines

A delivery of air express cargo to a transport plane by a local package delivery service

The efforts of many operators to organize their own pick-up systems have been foredoomed to failure. An adequate ground organization to pick up and deliver air express loads only more often than not has cost more than the total revenue that the traffic would bear. Failure to provide an adequate terminal service only serves to discourage legitimate traffic Attempts to get along on company passenger buses, or with rented equipment making pick-up calls at one or two depots only and with no delivery service, and various other expedients tried by the operators themselves have often been sorry failures

The plan recently entered into between several operators and the Western Union and Postal Telegraph companies is as good as any that has been tried to date The telegraph companies blanket the metropolitan areas of the country with an excellent messenger boy service, supplemented in some cities by light truck collection and delivery systems While the use of messenger boys may serve to develop an air express package service it cannot be considered a solution of the ground handling problem for general express purposes

One possible way to get around the difficulty might be through the use of local parcel handling companies which are self supporting on the basis of their own local business. Air express could be handled by such concerns with a minimum disarrangement of the established system, and at a relatively low charge per package handled Such an organization is now in operation in a number of cities of the Pacific Coast and in one eastern center. This company operates automobiles of special design for the rapid handling of rush parcels They call daily upon certain commercial houses of the cities it serves and could easily render a similar service on air express traffic. When the airlines of the country cooperate to authorize one such service, and only one, to act as their agent in each large city then we may look for the development of air express in real volume

Routing difficulties

Finally, the somewhat jumbled airport and airline situation in some localities has made it difficult to route air express loads with any sort of continuity In the past it has been common practise for every airline to have a separate terminal in each city, and an air express package coming in over one airline and continuing to its destination over another has often been forced to take a ride of from 20 to 30 miles between airports Such a situation makes the ordered development of air express traffic difficult, but this matter is being much improved at the present time through the insistence of the Post Office Department that all mail carriers operating out of a city use the same airport. It will not be practical to handle air express on a national scale until all air express lines cooperate to use a single terminal in each city

The problem of uniting air transport groups in an attack on the air express problem, and of gaining for them the necessary financial support, is the real problem that confronts all interests seeking to further the development of air express traffic in this country Such action on the part of air transport operators is not unreasonable The railroads of the country found it possible to cooperate in the matter of rail express because it was to their mutual advantage to do so, and it will be of mutual advantage to the air transport operators, to the entire aviation industry, and to the general public, to cooperate in the establishment of adequate nation wide air express facilities.

Breaking a speed record

An analysis of the flying technique employed by Flight Lieut G. H. Stainforth in setting a new world's speed record

By Maj. Oliver Stewart

THE flying technique adopted by Flight Lieut G H Stainforth when, in the Vickers Supermarine Rolls-Royce S 6B, he broke the world's 3-km speed record at Calshot Air Station in England on Sept 29, possessed many points of interest to pilots

The problem before Stainforth was to obtain the maximum speed in the 3-km base without losing height during that time or during the 500 m approach run, and without ever exceeding the altitude prescribed by the rules during the whole flight. He could therefore use a preliminary dive but only under strictly limiting conditions

He adopted a mean between the extremely steep dive used by Flight Lieut. D'Arcy Greig on an earlier attempt on the world's record and the long very flat dive used by himself on his own previous attempt He timed this dive so that it ended just before the 500-m entrance run

Before starting the dive he went some 6 or 7 miles away and climbed to the maximum permissible height or nearly to the height of the check airplane which carried one of the official observers He then turned and flew level at full throttle, allowing the speed to build up The last 5 m p h takes some time to develop in these machines and he timed his approach run so that the plane was travelling at its maximum level flight speed before starting his dive He then dived fairly steeply and did not flatten out from the dive until he was about 100 ft. from the water, going a good deal lower than he had done on his previous attempt, or indeed then any other pilot who has attempted this record in recent years in England.

To maintain an accurate line during these runs was a matter of some difficulty The visibility was between 3 and 6 miles and Stainforth was forced to use cloud formations for aiming his machine These however provided an excellent mark and enabled him to maintain a perfectly true course on all runs

After he had made the attack on the record he gave privately an estimate of the speeds he had attained. When the automatic moving picture films had been developed and analyzed and the calculations had been made it was found that Stainforth's estimate of his speed was only 3 m.p.h out. The readings of the revolution counter and the air speed indicator cannot be relied upon at the top of the speed range so that Stainforth's estimate was almost entirely derived from general inferences.

Flying Equipment

THE PILGRIM 100A TRANSPORT

AN interesting example of a passenger airplane built around the requirements of modern transport operations is the Model 100A Pilgrim, manufactured by the American Airplane and Engine Corporation of Farmingdale, N Y In the past, operators more often than not, have had to accept from the manufacturers equipment which had to be modified in many details before being suitable for their particular requirements This usually involves extra expense and reduction in space and payload

For example, it is usually left to the operator to install the radio instruments he desires as best he may, placing the transmitter and receiver in odd corners and putting up the wiring and antenna more or less to suit his fancy In the Pilgrim however, the radio installation has been an integral part of the design from the beginning and consequently there is no necessity for hit-or-miss wiring, reduced baggage space, or reduced rated payload on this account The designer is thus able to so distribute the weight of the radio equipment that there is little possibility of serious unbalancing of the airplane in service due to weights placed in locations where additional loads were never contemplated in the original design The Western Electric radio equipment includes a short wave transmitter and receiver, and also a long wave receiver, all powered from dynamotors so that the sets will operate when the machine is on the ground

Another feature which was given considerable attention in the preliminary work, was passenger comfort and convenience. Sufficient depth and breadth were built into the fuselage so that the nine passengers have ample room to sit and move about in comfort The cabin wall has been thoroughly insulated for sound and heat A number of individually operated registers located in the cabin wall below each passenger seat control the entrance of the warm air to the cabin Over each seat is a small ventilator for the admission of cool, fresh air The individual cold air ventilators are connected to ducts in the cabin roof, which communicate with small screened openings in the leading edge of the wing outside the slipstream. It was found that by manifolding the individual ventilators rather than having them communicate separately with the outside air, there was considerable reduction in noise in the cabin Vibration has been reduced by supporting the engine and mount on rubber insulators

The seating equipment consists of six individual chairs facing forward and a wide bench for three people located against the forward cabin bulkhead, facing to the rear. The bulkhead, incidentally, is solid, and there is no means of direct communication between the cabin and the pilot's compartment except two small sliding windows Access to the cabin is to be had through two large doors at the rear. The broad windows afford unusually good passenger visibility Toilet and washroom facilities are provided.

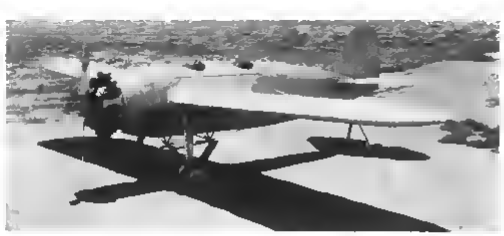
The pilot's cockpit is located well up on the forward part of the fuselage just ahead of the wing. The range of vision from the cockpit is unusually good, as the wings are about on a level with the pilot's eyes and by moving his head slightly, he may see over or under them as he desires Vision forward is excellent as the seat is high enough above the engine so that the pilot may easily see over the cowling For a transport airplane of equal size, the blind areas are unusually small.

Below the cockpit ahead of the cabin is located a mail compartment of 47 cu.ft capacity. Passengers' baggage is carried in three large metal compartments below the cabin floor, accessible from outside.

The machine in general is a high wing strut-braced monoplane of more or less normal appearance Although there are many ingenious design details involved (some of which will be described in later issues of AVIATION) the construction and materials employed are conventional. The fuselage framework, and landing gear are built up of chrome molybdenum welded steel tubing, as are the main wing beams The latter are of interest in that they are completely heat-treated after assembly and have been made interchangeable Wing ribs and the tail surfaces are built up of riveted duralumin tubing and formed sheet members The entire assembly is fabric-covered The machine is designed so that folding wings may be furnished with an additional weight of 35 lb Goodyear air wheels, or Bendix standard wheels and brakes are supplied as optional equipment, and a full castering tail wheel is provided The power plant consists of a 575-hp Pratt & Whitney Hornet Model B-1 engine direct connected to a metal propeller

Span	57 ft 0 in
Length	38 ft 2 in
Height (over radio mast)	10 ft 5 in
Wing area (including ailerons)	438 sq ft
Weight empty*	4 503 lb
Useful load	3,947 lb
Payload	2 247 lb
Gross weight	7 700 lb
Wing loading	17 lb per sq ft
Power loading	13.5 lb per hp

*Including battery flares fire extinguisher system landing lights and radio equipment



The Ensco B-7-C trainer

A NEW MODEL B-7-C EMSCO

A MODIFIED model of the B 7-C training monoplane (A.T C 424) has been announced by the Ensco Aircraft Corporation Downey, Cal. The B-7 C is almost identical with the B 7 except that numerous detail refinements of structure fuselage form, landing gear load struts and the tail wheel is full pneumatic. The general specifications are

Span	41 ft 3 in
Length overall	28 ft 1 in
Height	8 ft 11 in
Gross weight	4 000 lb
Weight empty	2 080 lb

THE BREESE R6C FREIGHTER

THE Breese R6C monoplane, developed by the Breese Aircraft Corporation Portland Ore., is a combination mail or express and passenger plane, carrying four passengers in an enclosed cabin and 570 lb of express in a separate compartment As the B-6, this plane is a conventional cabin passenger plane seating six and pilot It is also designed for easy conversion to full freight load with a payload of 1 250 lb

The plane is a conventional strut braced monoplane powered with a 300-hp Wright engine equipped with a modified NACA cowling The wing is mounted several inches above the fuselage The latter is of rigid truss steel tube construction, and the wing of wood. Fabric covering is used throughout except in the case of the freight plane, which uses metal covering from the nose to the pilot's cockpit aft of the wing. Bendix wheels are equipped with balloon type tires Rusco type shock absorbers are used on the

The Breese R6C Freighter

AN AIRCRAFT DIESEL ENGINE

A FULL DIESEL aircraft engine burning ordinary diesel fuel of 24 to 30 deg gravity is under development by the Aviation Diesel Engine Company, Ltd., Los Angeles, Cal The engine is of seven-cylinder static radial air-cooled design with 7-in. bore and 7-in stroke, and is rated at approximately 400 hp at 1,500 rpm It weighs about 1,400 lb Maximum pressures within the cylinders do not exceed 610 lb per sq in After more than 200 hours of torque stand testing the engine has been submitted for Department of Commerce tests

BURDETTE S-30 MONOPLANE

THE Whites Aircraft Company of Des Moines, Iowa, has announced a new light monoplane with side-by-side seating for two persons The machine is of the parasol type, powered with a three cylinder, 30-hp. Szekely engine. Steel tubing is used for fuselage, tail surfaces, and landing gear, and wings are of all wood construction. Elevators and rudders are operated by cables, while the ailerons are operated with push and pull tubes The landing gear is of the full split axle type, equipped with air wheels without other shock absorbers. The cowling around the engine is unusually complete and gives a relatively smooth streamline from nose to tail The general specifications as given by the manufacturer are as follows

The Burdette S-30

Span	35 ft
Length overall	23 ft.
Wing area	160 sq.ft.
Gross weight	856 lb
Weight empty	556 lb

APPROVED TYPE CERTIFICATES

DURING the period Sept 12 to Oct 10 the Aeronautics Branch of the Department of Commerce issued the following Group I approved type certificates: 444, Curtiss-Wright Sedan 15D (Wright R760 240 hp), 449, Alexander D-2 (Szekely SR3-0 45 hp); 450, American Eagle-Lincoln, American Eaglet B31 (Szekely SR3-0 45 hp.); 451, Northrop Alpha 4 (Wasp 420 hp), 452, Nicholas-Beazley NB-8G (Genet 80 hp) 453 Waco PCF (Jacobs LA1 170 hp)

Aircraft at Work

Continental Oil tour by plane aids business

OIL companies have been most progressive of any industrial group in the use of aircraft in business. And they have employed the plane for other than merely colorful advertising, transportation of executives and members of the sales staff for inspections, conferences and direct customer contacts have been regular parts of the travel program and budget in addition to the prestige and general promotion which display of a company's plane affords.

A very ambitious sales effort based on use of aircraft was staged last summer by six marketing executives of the Continental Oil Company, Ponca City, Okla. They flew in two company owned planes—a Wasp-engined Ford and Challenger Robin—on a 11,985-mile trip over 30 states and two Canadian provinces within a period of 78 days—about 110 hours of flying. The machines functioned satisfactorily throughout the cruise, the total repairs consisting of two minor adjustments which consumed but 3 hours 20 min. Capacity loads were carried on about every lap.

The itinerary was plotted to include principal points in all of the company's twelve marketing divisions. An average of 160 miles per day was maintained for the entire tour but on one day the party flew 900 miles. Most of each business day was spent effectively on the ground, though to accomplish this it often was necessary to fly in the early and late parts of the day. Division managers and their assistants accompanied the party in each division.

Comparing the cost and efficiency of the tour with a similar tour by other means of transportation, the company estimates the planes enabled the trip to be made in half the time it could otherwise have been done and at about half the cost. Under usual conditions, twice as much executive salaries would have been chargeable to the tour, while depreciation on the plane and pilots' salaries would have continued anyway. The conveniences afforded, the mobility, value of sales consummated, and extent of publicity and good will obtained, made the tour a great success from the company's point of view. The tour is credited with having noticeably stimulated the company's business.

College adds flying course to curriculum

COLLEGE of William and Mary at Williamsburg, Va., is installing the first course in flying instruction as a part of college curriculum in the country. The course has a department devoted to ground school subjects and another to the actual flying. The ground school work is designated as Aeronautics 101 and the instructors are regular members of the faculty. Of course, graduates of the course receive regular credits.

The ground school involves no extra charges. Flying instruction costs $150 in addition to the tuition for the private pilot course and $400 for Commercial pilot course. Lieut.-Col. Earl Charles Popp as director of aeronautics has charge of both ground and flying instruction. Two Kitty Hawks and a Fleet have been purchased; one of the Kitty Hawks is equipped for instruction in blind flying. The college has its own airport.

Flying executives of the Continental Oil Company

New York State uses plane in forest patrol

THE New York State Conservation Department is using effectively a Fleet for forest fire patrol and general observation of large timber tracts, particularly the state forest preserves under its control. The plane is to be used also for occasional aerial photographic missions and experiments are being planned for its utility in surveying fish and game stocking points and in planting fish. This latter will be a follow up of some work which has already been done through a commercial contractor at great saving of time and expense.

In its main work of forest fire patrol and general observation, the machine co-ordinates the widely scattered system of fire observation and fighting units. These are located at strategic points throughout the state but cover principally the more than 2,000,000 acres in the Catskill and Adirondack preserves and the area between Albany and New York City, where there are no fire towers.

Klemms used in new joy hopping wrinkle

IN the belief that flying should, as far as possible, be carried to the public and that there is a profit in operating from a small field where the overhead is negligible, the Aeromarine Klemm interests sponsored a number of noteworthy enterprises last summer. Basing the machines at what were nothing more than level farm fields, the company featured short hops at the rate of $1 per person per hop. Low price instruction and some short distance charter work also were carried out.

Expenses were kept down by doing without a hangar and by using a naturally smooth field which is an integral part of the farm. The first field selected is 5 miles from the town of Matawan. In the month ending Sept. 15 a $2,000 plane earned a gross of $1,033.25 at the above rate, cost of gasoline and oil amounted to 6 cents per hop. The field included but 65 acres and a season's crop of alfalfa and hay had been removed before the plane was allowed on it about Aug. 15. Experience with the first venture encouraged expansion to two others—Hightstown and Woodbridge—with equal success.

Airport Management

A Douglas on the turntable at the Catalina base

Turntable aids handling of Catalina amphibions

A UNIQUE amphibion base has just been completed on Catalina Island at a cost of about $250,000 for the new Wilmington-Catalina Airline, Ltd. Because of the rugged shore line, it was necessary to cut a niche with steam shovels in order to secure sufficient handling room, and no attempt was made to build a field large enough for the amphibions to land on with wheels. To facilitate handling still further, a turntable with a wooden platform was installed at the junction of the ramp from the water's edge and the taxi-way from the hangar.

This makes it possible to turn the machines with ease and speed up operations considerably. The base is located at Hamilton Cove near the St. Catherine Hotel a mile north of Avalon.

The rest of the equipment is conventional. There is a 60x80-ft. steel and concrete hangar, a two-story administration building of Moorish design; a garden patio, and a concrete ramp with a 6 per cent grade. Douglas and Loening amphibions are used. Traffic for the first six weeks of operation totaled approximately 2,500 persons. The ten-place Douglas alone carried more than 1,000 passengers over the 27-mile route during the first 30 days of its operation.

School's special rates attract students

THE success of each operator on his airport is one of the concerns of airport executives whether the company be one with which they are connected directly or one of the lessees. Flying schools have been forced to adjust themselves to changing economic conditions and there are a number of examples of promising innovations.

Douglass C. Fonda, chief pilot of the Newark Air Service branch at Westfield (N. J.) Airport has had noteworthy success with his scheme of providing instruction at the rate of $5 per lesson. Since he started operations early in July, about 40 students, nine of whom are women, have responded to the offer and the planes are flown about ten hours daily. The very light type of plane—in this case the Curtiss Junior—is essential to such a low rate.

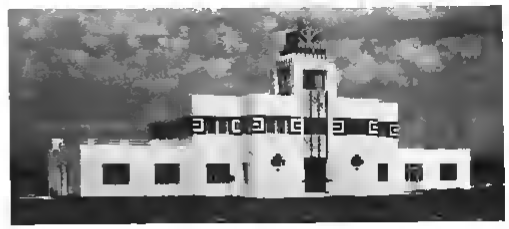
Emphasis is placed on the lesson rather than on the time it takes. The fee is but $5 whether the lesson is 20 min. or 40 min. long. Ten have soloed, one who had never been in an airplane before starting the course was soloed in 1 hour, 20 min. Others have required up to 5 hours. The number of lessons up to the point of qualifying for a private license averages between 20 and 30. It is possible to secure such a license for about $125. Those wishing to graduate to heavier planes are charged more, of course. The plan is profitable as long as there is a steady volume of approximately twenty or more students.

Curtiss-Wright Flying Service also has taken special measures. It has been offering through its usual advertising channels flying instruction at the rate of $5 per lesson. This lesson is of only 10 min. duration and is just about equal to the charge for a full hour at the regular tuition fee. However, splitting the fee in this fashion has a favorable psychological reaction and places the lesson within the reach of many who could not afford the complete outlay.

In many cases it works out as an introductory course in which the prospect gets a taste of instruction and signs up for the regular routine. It is possible however, to complete the course on the $5 per lesson basis. Since the plan was started in July about 50 have taken advantage of it at the Curtiss-Wright Valley Stream (L. I.) base alone. At many of the other bases the response has been even better than this. Regular instruction planes are used. The chief obstacle to the plan has been the expense of the physical examination for the federal student permit.

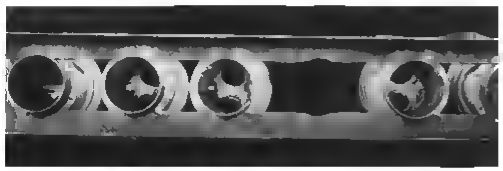
An interesting airport building

AN EXCEPTIONALLY interesting architectural treatment of an airport administration building is the headquarters building at the Shreveport (La.) Municipal Airport. The structure is of stucco with black and gold decorative trim. The field includes 346 acres with an all-way turf surface and is located but 1.4 miles from the business district on the north side of the city in a bend of the Mississippi River. There is a 100x115-ft. all steel hangar of conventional design. The complete project, with lights, cost $330,000.



The administration building at Shreveport

Servicing Short Cuts



A part of the Thompson cylinder repair rack

A TAIL SKID DOLLY FOR THE HANGAR

TO facilitate the movement of airplanes about the hangar at the Atlanta Repair Depot of Eastern Air Transport, Inc., a number of small three-wheeled dollies are kept conveniently at hand. Each consists of a triangular steel plate in the corners of which are bolted ball bearing casters. A short section of iron pipe of relatively large diameter is welded in the center of the top of the plate to form a socket into which the tail skid shoe fits.

A PORTABLE VACUUM CLEANER

AN Electro-Lux portable vacuum cleaner is used to good advantage in cleaning the interior of planes in the Boeing Airplane Company hangar on Boeing Field, Seattle. This cleaner is readily portable, is not easily damaged, and will pick up foreign matter of all sorts which it would be difficult or impossible to reach without dismantling part of the plane. The cleaner is equipped with an extension hose and nozzle which may be used with either suction or blowing action as required.

A STAND FOR CYLINDER SERVICING

THE Cleveland Repair Depot of the Thompson Aeronautical Corporation has developed a simple and effective rack for supporting the cylinders of air-cooled engines for valve grinding, adjustment, or other overhaul operations. The rack consists of a long rectangular framework built of angle iron so mounted on trunnions between a pair of metal A frames that it may be rotated about its long axis. An index plate mounted at one end and provided with removable pins, permits locking the frame in any desired position with respect to the support.

By cutting away portions of the flange of the angles and by drilling suitably spaced holes, provision has been made for mounting nine air-cooled engine cylinders in line on the rack. When bolted in place, the line of cylinders is held firmly at a height convenient for valve grinding or other work, and by turning the entire rack, it is possible to swing to a position most suitable for any desired operation.

Tail skid dolly

LIGHT PLANE ENGINE SERVICING

A UNIQUE method of servicing light airplane engines is practised at the General Western Aero Corporation, Santa Barbara, Cal. The plane is tipped up on its nose, the front end being supported by a suitable stand or box against which the propeller hub rests. Normal designs are sufficiently nose heavy when empty to stand firmly to permit the mechanic to work on all parts of the engine without having to reach up, or to climb on boxes or ladders. The plane is brought back to normal position by means of a rope tied to the tail skid. One man can easily lift the average light plane to position and return it to normal.

GROUNDING STATIC ELECTRICITY

TO prevent fire originating from discharges of static electricity on airplanes under repair it is always advisable to provide an adequate electrical connection between the frame of the machine and the ground. In many shops haphazard connections are made which are often unsatisfactory from an electrical standpoint, and involve long stretches of loose wiring scattered about the hangar floor over which anyone working about the machine may easily trip. The Pacific Air Transport Division of the United Airline reduced this hazard by building into their hangar floors at Seattle, Burbank, and San Diego, a permanent electrical grounding system with outlets spaced on approximately 40-ft. centers in both directions. At each outlet point a 5-ft. copper tube was driven into the ground and all tubes interconnected electrically. The network was then wired directly to the metal framework of the building. The outlets themselves consist of small solid copper knobs extending less than ½ in. above floor level. Lengths of insulated cable with large spring clips at each end are stored in convenient locations about the hangar, and as soon as an airplane is put into the shop for any repair work, one end of a cable is fastened to a grounding plug, and the other to a convenient metal part of the airplane. The wide distribution of outlets on the floor insures that a convenient electrical ground can be obtained for airplanes in any part of the hangar with a minimum of loose wiring on the floor.

A convenient method of servicing light plane engines

1930 UNITED STATES AVIATION REPORTS, (1930 USAvR) *Arnold W. Knauth, Henry G. Hotchkiss, Allen L. Furlow and Emory H. Niles, Editors, United States Aviation Reports, Inc., Baltimore, 573 pages*

THIS is the third annual volume of a series dealing with the law in relation to aeronautics as it has been developed in the United States. The first volume included all available material to November 1928, the second volume from that date to November, 1929, and the present volume covers the intervening twelve months to November, 1930. Aside from court decisions of which thirty are reported, the current volume devotes 76 pages to Federal Statutes, the Amendments and Supplements to the Air Commerce Regulations, the "Minimum Safe Altitude" Amendment to the Federal Air Traffic Rules, the Airport Rating Regulations effective Sept. 1, 1930, and the Foreign Air Commerce Regulations. A cumulative table carries references to prior federal statutory and regulatory law.

There are included also, four opinions of the United States Attorney General, six decisions of the United States Comptroller General and four State Administrative Decisions. One hundred and thirty-two pages are given over to State Statutes and Regulations and a cumulative table makes reference to the comparison with prior state laws and regulations an easy matter. There is a separate Digest of State Gasoline Tax Laws and an Index-Digest of the entire subject matter of the volume.

As appears proper from the standpoint of importance to the aviation industry and for that matter from a purely legal point of view as well, the volume opens with reports of the cases of "Smith v. New England Aircraft Company" and "Swetland v. Curtiss Airports Corporation," which cases deal with the law of nuisance as applied to airports. Other decisions reported deal with negligence in the operation of aircraft, with insurance, with conditional sales, with patents, in fact with all phases of the law as applied to cases involving any phase of aeronautics, decided during the period covered by the 1930 reports.—HAZLETON MIRKIL.

AIR TRANSPORT OPERATION, *by Wesley L. Smith, McGraw-Hill Book Company, New York, 1931, 316 pages, $4.00*

A BOOK on air transportation could have no better guarantee of quality than the authorship of Wesley L. Smith, chief engineer of National Air Transport. Unfortunately his record of long and varied activity and steady rise in prominence in the air transport field is omitted from below his name on the title page, and potential readers may not realize with what authority he speaks.

Mr. Smith has written entirely from the point of view of the operating man. Nothing is said of finance, or accounting or of traffic solicitation. The chapters treat of such subjects as airways radio, airports, power plants, and flight procedure. They are notably free of theory and they lack references to history and to foreign practices. "Air Transport Operation" is a straightforward record of American experience as it has come within the author's own observation and as it has been guided by the Post Office Department and by the Department of Commerce. Although it makes no pretense of being a complete text on the whole range of possible practice, it is the best existing book on operating methods. It ought to be read by everyone ambitious to get into air transport work, but it should be relatively even more popular in Europe than in the United States.

DYNAMICS OF AIRPLANES AND AIRPLANE STRUCTURES, *by J. E. Younger & B. M. Woods, John Wiley & Sons, Inc., New York, 1931, 263 pages, $3.50*

THE advanced theory of the airplane divides itself into three parts, fluid dynamics, the rigid dynamics of the airplane as a whole with special reference to stability, and the study of the relations between the part of the machine, with special reference to structural strength and to such specialized problems as wing flutter. The two sections of the subject first mentioned were covered for American students some twelve years ago by Dr. E. B. Wilson. The third part has been the particular interest of Professors Younger and Woods of the University of California, and this volume is the result of their studies in the past several years. It is by far the best of its kind for the student who has a good knowledge of college mathematics, but has not yet acquired enough background to plunge directly into memoirs dealing with individual and narrowly limited problems. Some attention is given to airplane stability, but that is of relatively secondary importance. Of much greater interest are the examinations of structural questions and particularly of flutter, torsion of propeller blades, engine vibrations, etc. All the necessary mathematical preparations beyond second-year calculus and elementary differential equations are included in the first part of the book. The second and third parts bear on the method of attack upon specifically aeronautical problems.

AVIATICUS *(German Aeronautical Yearbook) 1931, Berlin, 396 pages*

"AVIATICUS" is a collaborative volume in the preparation of which the German aircraft industry and Deutsche Lufthansa and other interests have taken an active part. A mixture of statistical data and miscellaneous information and of articles on recent developments, it has some similarity of purpose with the Yearbook of the Aeronautical Chamber of Commerce. Thus, for example, more than 40 pages are devoted to telling what Deutsche Lufthansa is, how it is organized, who runs it, and what it has done, with copious statistics and facts. Other companies are similarly treated. German aircraft insurance is explained. The

most important of non-German transport activities are enumerated. Each German manufacturer of aircraft and engines is very briefly covered as to history, organization, and present products. Miscellaneous special subjects, such as sport flying, and aircraft shows, and the work of the classification societies on aviation, are covered in special articles by eminent authorities A Who's Who in German Aviation, prepared by the Tschudi Research Library of the German Aero Club, with the backing of the Guggenheim Fund, includes some 600 names. Perhaps the most interesting of all the book's contents for reference, especially for those not reading German, is the exceptionally complete and fairly (although by no means perfectly) accurate list of all the important long-distance flights made anywhere in the world from the end of the War to the end of 1930

L'Annee Aéronautique, 1930-31, *by L. Hirschauer and C Dollfus, Dunod Company, Paris, 437 pages.*

As usual this volume comes by courtesy of the Zenith Carburetor Company, and as usual it contains practically no advertising

The choice of American machines for the collection of monographs on new types is rather curious, especially in the light touring class, where only two American planes are mentioned. The neglect of American power plants is still more conspicuous, as there is no mention of any type except the Menasco

As usual, however, the book is most valuable as a tabulation of flight performances rather than of technical information The records of flights of the year, of notable cross-country voyages, and of races and competitive tours are indispensable for anyone who has occasion to speak of such matters and wants his information to be accurate The brief reports on operations of air transport lines throughout the world and on the organization of aeronautical departments and of military air services is as usual a valuable reference and source of statistical material. The journalist turns constantly to L'Année Aéronautique for information, and it is one of the five or six indispensable works of reference in any general aeronautical library.

Aircraft Engines, *by Minor M. Farleigh, John Wiley & Sons, Inc., New York. 1931, 277 pages, $3*

Mr FARLEIGH writes for the aircraft mechanic or for the vocational school, where his book should prove very useful as a text. He has made no effort to treat of the problems of engine design in any very extended fashion, nor has he much to say of the materials and methods of engine construction. His interest is rather in the operations which lie within the control of the mechanic For example, almost nothing is said of cylinder form and design nor of valve proportions and materials, but more than thirty pages are devoted to an elaborate discussion of valve timing.

The book suffers at certain points from too large a dependence on a limited number of commercial sources. Thus, the chapter on supercharges is based exclusively on the work of the General Electric Company and there is no mention of the Roots blower type

Three chapters are given over to very thoroughgoing descriptions, of instruction-book type, of the Pratt & Whitney Hornet, the Kinner K-5, and the Packard diesel. Perhaps the most interesting feature of the volume is the collection of ten detailed case histories of unusual engine troubles and explanations of the processes by which they were located and cured.

Das Segelflugzeug, *by Dr Werner von Langsdorff, J F. Lehmanns Verlag Munchen, 1931, 230 pages, 9 Marks*

THE second, and completely revised and modified, edition of a book originally published in 1923 It is essentially a conspectus of present glider design practice, in which some 40 pages of general history of soaring machine development and classification of present-day glider types are followed by twice that space devoted to the detailed discussion of the design and construction of various parts and of the relations of their proportions to the efficiency of the finished soaring machine

The remainder of the book looks very much like another volume of von Langsdorff's Taschenbuch der Luftflotten containing photographic illustrations of 120 gliders with brief design specifications on each one, and 50 pages of photographs of structural details with generous captions

Element di Aviazione, *by G. A Crocco, Alberto Stock, Rome, 615 pages, 120 lire*

GENERAL CROCCO, professor in the Aeronautical Engineering School at Rome and director of Aeronautical Materiel at the Italian Air Ministry, has been adding to his reputation as an acrodynamist and an engineer for some twenty years The present volume, although not of a very advanced nature, is an excellent exposition quite worthy of its author It covers essentially the same ground as E P Warner's "Aerodynamics of Airplane Design" except for the inclusion of a long section on propeller performance and the relation between the propeller and the power plant The earliest sections include the usual material on aerodynamic data (including a number of very interesting designs and curves for Italian airplanes of exceedingly novel form), performance, equilibrium, and stability (the last much more briefly treated than in the Warner book). Although in no sense a sequel, or incomplete in itself, the book is a companion piece to a more general and more advance volume by General Crocco, "Aeronautical Problems from the Beginning to the End of the War"

Aerial and Marine Navigation Tables, *by John E Gingrich, McGraw-Hill Book Company, New York, 1931, 63 pages, $2.50*

NAVIGATORS and mathematicians have curious enthusiasms of their own, and they are prone to become partisans of the particular form in which they are accustomed to having their data presented. The merits of a particular arrangement of tables depend largely on getting used to it. Lieutenant Gingrich of the Navy and formerly an instructor in navigation at Annapolis has drawn upon all available sources, especially upon the work of Dr Ogura of the Japanese Navy and the more recent studies of Commander Weems and of Mr E B Collins, and has presented the results in convenient form, bound in semi-flexible leatheroid. The usual brief explanation, and presentation of illustrative examples both on sun sights and star sights, precede the tables themselves From the mechanical point of view the worst criticism that can be made is that there is overcrowding in some cases, with too many columns in a page and too many rows in a column.

Aviation Atlas, *Gulf Refining Company, Pittsburgh, Pa., Second edition*

REVISED and brought up to date, a second edition of the Gulf Refining Company's aviation atlas is now available Charts, photographs, maps, and tables occupy the twenty pages Copies may be procured from the Pittsburgh office

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THE reviewer feels almost apologetic, on looking back over last month's reviews and over the current budget, for speaking of so many volumes in terms of high praise. He has not abdicated the critical function, nor has he gone "soft" and begun to swap compliments with authors It is the happy fact, that, after a period in which a great many very bad books on aeronautics appeared, the current summer's crop has attained an extraordinarily high level. Eighty per cent of the volumes that have reached Aviation for review in the past three months really deserve a large and attentive audience

Design Novelties

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The tail wheel on the Fleet

AN interesting tail wheel mounting incorporating full shock absorption through the use of rubber cord and a semi-balloon tire, arranged not only to be steerable through 90 deg but full castoring through 360 deg when required, is standard equipment on the Model 8 and 9 Fleet biplane manufactured by the Consolidated Aircraft Corporation, of Buffalo, N. Y. The main structural member is a vee-shaped, heat-treated casting which supports the vertical spindle of the forked tail wheel mounting through large bosses at the extremities of the two arms The assembly is mounted in the fuselage on a shaft supported on the two lower longerons at the first fuselage panel point forward of the tail-post A pair of welded tubular brackets are bolted to the free end of the swinging bracket which carry suitable spool-shaped connections for the shock cord as well as a pair of rubber stops to limit the downward travel of the whole assembly. The latter engage in a pair of semi-circular projections welded to a short strut on the fuselage A short section of steel tube welded across the lower longeron just aft of the tail wheel furnishes a point of attachment for the shock absorber cord

The tail wheel spindle carries at its upper end a grooved pulley in which a flexible steel cable engages connecting it to the rudder pedals in the cockpits An internal latching device releases the connection between the pulley and the spindle when the tail wheel is forced beyond the 90-deg position on either side The wheel is thus made free castoring for convenience in handling the airplane on the ground When returned to the normal position, the steering mechanism automatically engages

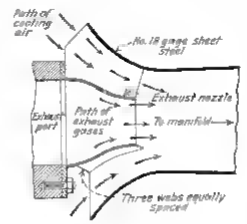
Tail wheel mounting on the Fleet

An air-cooled ejector type manifold

IT HAS been well established by tests both by the National Advisory Committee for Aeronautics and the Army Air Corps, that most fires following crashes originate from the spilling of gasoline or oil on hot engine manifolds After a long series of tests, engineers of the NACA have designed an ejector type manifold which is self-cooling to a temperature below the ignition point of the liquid fuels carried on aircraft.

Each engine exhaust port is fitted with a Venturi-shaped nozzle, surrounded by an annular opening communicating with the outside air The high velocity exhaust gases induce a flow of cool atmospheric air into the exhaust manifold in sufficient volume to materially reduce the manifold wall temperature In tests on a Fairchild FC2 W2 the maximum temperature of the manifold was found to be from 200 to 400 deg lower than that of the original equipment The performance of the airplane was not materially changed by the addition of the special manifold but the latter was not quite as effective as a silencer as was the original

Raw fuel sprayed into the manifold with the engine idling could be ignited, but the fire occurred from direct contact with the flaming exhaust gases rather than the wall of the manifold, as thermocouples located in the walls indicated that they were well below the ignition temperatures of the fuel



The NACA ejector type manifold

New undercarriage for the Condor

ALTHOUGH much of the improvement in performance shown by the new model Curtiss Condors recently delivered to Eastern Air Transport, Inc., can be attributed to the cleaning-up of the nacelles (page 605, Aviation, October 1931), a certain percentage of it must be credited to the more careful attention given to fairing-up the landing gear All struts of the main landing wheel are fully streamlined and generous fearings provided at all points of attachment on the underside of the wing Streamline housings have been furnished to cover completely all external projections and operating gear at each wheel All wheel cowlings have been made in sections which are readily removable for servicing operation on the wheels, and brakes

The Condor tail wheel

The Buyers' Log Book

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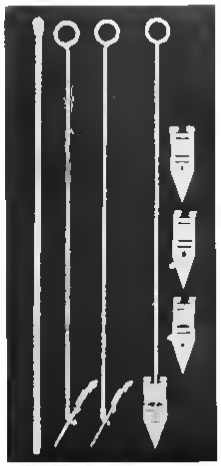
Mooring anchor

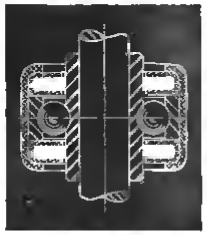
Whenever airplanes must be left out in the open for any length of time it is necessary that they be well tied down to prevent damage by wind. To take care of such contingencies, the Stanley Works of New Britain, Conn., has developed a compact mooring anchor designed to be carried as regular equipment in airplanes.

It consists of one shaft or ramming rod, three tie-down wires, and a half dozen arrowheads packed in a canvas bag, the whole weighing 2¾ lb. To operate, the ramming rod is inserted into the slot in an arrowhead, and the latter driven point first into the ground by hammering on the butt of the shaft. After the head is driven in so that only the looped end of the tie down wire projects above ground level, the ramming rod is withdrawn from the ground and tension is put on the wire. The pull tends to withdraw the arrowhead, but, due to its shape, it turns sidewise in the ground, making it impossible to withdraw it further.

When the airplane is released from the mooring, the hold-down wires may be salvaged by twisting them in order to unscrew them from the arrowhead. They may then be withdrawn, but the arrowheads remain in the ground and new ones must be used for each mooring. They are buried deep enough so that they will not damage anything on the surface, and the cost is low enough so that a replacement is not burdensome. — AVIATION, *November, 1931*



The Stanley mooring kit



The Fafnir SIK-3 bearing

Indicating instruments

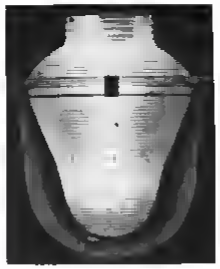
The General Electric Company of Schenectady, N. Y., has announced a new line of indicating instruments for aircraft use, including oil, air, and cooling liquid temperature indicators, and also oil and fuel pressure indicators. Temperature and pressure elements are separate units. Those for oil, fuel, or cooling liquid measurements are designed to be attached to standard fittings, replacing the conventional temperature bulbs and pressure tubing. Air temperature indicators for use as ice warning devices, are arranged for mounting on any convenient part of the aircraft. Instrument cases conform to the Army-Navy standards. — AVIATION, *November, 1931*

Tachometer

Revolution indicators for practically all purposes, are being manufactured by the Barbour Stockwell Company of 205 Broadway, Cambridge, Mass. The Model F Reliance Tachometer, with a range of 200 to 2,400 r.p.m., is designed especially for aircraft. Instruments are built according to U. S. Aircraft standards and may be obtained with either plain or luminous dials.—AVIATION, *November, 1931*

Ball bearings for controls

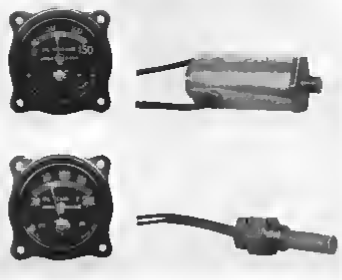
To meet a growing demand for small ball bearings in airplane controls, the Fafnir Bearing Company have recently put on the market a series of bearings known as the SIK-3 cartridge type aircraft bearings. Since these units are used extensively in exposed locations (rudder, elevator or aileron hinges), they are completely enclosed and sealed against the entrance of water and dirt by felt washers. They are easily assembled and are permanently lubricated, and are designed to compensate for about 2 deg. of misalignment without excess friction.—AVIATION, *November, 1931*



Holophane boundary light

Boundary light

The Holophane Company, Inc., of 342 Madison Ave., New York, N. Y., has announced a new globe for use on boundary lighting circuits of airports. The globe has been designed to conform to the light distribution requirements of Specification No. 451 of the U. S. Department of Commerce and to fit present standard boundary globe fittings. It is furnished with a smooth exterior to minimize dust and dirt collection, and is available in several colors to conform to local requirements.—AVIATION, *November, 1931*



G. E. oil pressure indicator and pressure unit (upper), and temperature indicator and external resistor (lower)

Technical Abstracts

FLUTTER THEORY AND PREVENTION

THE FLUTTER OF MONOPLANES, BIPLANES, AND TAIL UNITS, *by R. A. Frazer and W. J. Duncan. R. & M. 1255, British Aero Research Committee*

IN continuation of the work presented in their earlier treatise on the fundamentals of flutter theory and flutter prevention (reviewed in AVIATION, Jan. 25, 1930), Messrs. Frazer and Duncan have written a number of supplementary reports dealing with some of the finer details and more specialized applications of their theory. In the new volume these smaller reports have now been brought together under one cover for more convenient reference.

Chapter I is concerned with the influence of the mobility of the fuselage on the development of flutter. This effect has commonly been disregarded, the implied assumption then being that the fuselage is not set in oscillation by the flutter of the wings. The present analysis indicates a very slight beneficial influence of fuselage mobility in the case of "longitudinal symmetrical" flutter, i.e. flutter in which the port and starboard wings oscillate in phase, and a marked rise of the critical speed when the flutter is of the "lateral-antisymmetrical" type i.e. when the port and starboard wings move in opposition. What experimental evidence there is supports the theoretical conclusions.

The flutter of biplane wings is the subject of Chapter III. The treatment, analogous to that previously developed for monoplanes, is very thorough and impressively mathematical. A large number of concrete conclusions are drawn from the theory and generally supported by experimental evidence. With regard to the nature of the flutter, it was found that the upper and lower wings may move either in phase or in opposition when the overhang is large but that they will always move in phase when the overhang is small. Of the recommendations aiming at the prevention of flutter, the following are the most important: (a) The stiffness of the wings and their bracing should be as large as possible. (b) The center of gravity of the aileron should be slightly ahead of the hinge. (c) The moment of inertia of the aileron should be small. (d) The aileron should be underbalanced aerodynamically. (e) At least one-half of the aileron should be inboard of the interplane strut. (f) The inter-aileron connection should not be outboard of the interplane struts.

An analysis of tail flutter follows. The oscillations which are most likely to become unstable are shown to be of the "antisymmetrical" type involving torsion of the fuselage and flapping of the rudder and of the elevators. The following recommendations are made regarding the avoidance of tail flutter: (a) The elevators should be connected by a tube very rigid in torsion. (b) The rudder should be as nearly symmetrical as possible with respect to the torsional axis of the fuselage. (c) All tail surfaces should be made as rigid as possible. (d) The center of gravity of the elevator and the rudder should be slightly ahead of the hinge. (e) The moments of inertia of the movable surfaces should be as small as possible. (f) All movable surfaces should be underbalanced aerodynamically.

It is of distinct interest to learn that the torsional stiffness of the fuselage has relatively little effect on tail flutter.

An account of a flutter investigation on the tail of a service airplane forms the last chapter of the book. The following conclusions were reached: (a) The flutter was essentially of the rudder-fuselage type. (b) Flutter would not have occurred if the product of inertia of the rudder (about hinge and fuselage axis) had been zero. (c) Calculation indicates that flutter would have been avoided if the tail lamp and bracket had not been fitted to the rudder. PROFESSOR MANFREO RAUSCHER

A PLEA FOR THE TWO-PLACE FIGHTER

NAVAL FIGHTING PLANES, *by F. W. Wead, Lt. Comdr., U.S.N. (ret.)* United States Naval Institute Proceedings, *August 1931*

THE work of naval fighting airplanes falls naturally into three categories: offensive patrols, operating at extremely high altitudes against a definite enemy objective; defensive patrols, disposed on the "stair step" principle at altitudes ranging from 12,000 to 15,000 ft. and finally protective patrols to escort convoys of slower airplanes flying at relatively low altitudes. Practically all the airplanes now in use for these three purposes are single-seater machines designed for maximum speed, climb, and maneuverability. Their armament consists entirely of two or more fixed synchronized machine guns firing forward through the propeller, making it necessary to maneuver the entire airplane to aim the guns. This feature imposes certain limitations which make

Catalogs

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The International Nickel Company, Inc. Two bulletins describing respectively the use of nickel alloy steel in Pratt & Whitney Wasp engines and Curtiss Wright engines have been recently published by the International Nickel Company of New York City. These bulletins are available on request.

Page Steel & Wire Company. Two bulletins of interest to airport operators have recently been published by the Page Steel & Wire Company of Bridgeport, Conn. The bulletin entitled "The Border Patrol" describes the various styles of chain link and wrought iron picket fences. The other publication is devoted particularly to aluminum fencing. Both booklets are available upon request to the manufacturers.

The Perfect Circle Company. The 1931 edition of the specification for Perfect Circle piston rings has been received. This book includes a description of the various types of rings manufactured by the Perfect Circle Company of Hagerstown, Md., with direction for their installation. It also specifies the proper rings to be used with all makes of automobiles, trucks, tractor, airplane and other internal combustion engines.

John A. Roebling's Sons Company. A general catalog of wire and wire rope products has been received from John A. Roebling's Sons Company of Trenton, N. J. The book, which is attractively and durably gotten up between flexible leatherette covers, contains 280 pages of information on wire rope products and their application. Cables for aircraft, both for structural and electrical purposes, are included.

the machine vulnerable to attack from certain blind areas. It has been definitely established that a single-seater with fixed gun is at a distinct disadvantage when attacking larger aircraft equipped with movable guns.

Taking into account the advantages and the limitations of the various machines, the indication is that a two-seater fighter is a badly needed intermediary type, primarily for protective purposes. Although the over-all performance of an airplane of given horsepower is somewhat reduced by the additional weight and room required for a movable gun and gunner, yet its superior powers of offense and defense would go a long way towards overcoming these disadvantages. For defensive purposes there is little doubt that the two-seater fighter is superior to any other type of airplane in service. By combining whole squadrons of single and two-seater fighters in the usual "stair step" arrangement, or by making a mixed formation, such as placing a two-seater fighter in the leading position in every three-plane section of fighting machines, with single-seaters on the two wing positions, tactical units of very high defensive and offensive powers may be evolved.

Side Slips

By ROBERT R. OSBORN

WE SEE that there was a successful test of one of the new Sperry robot pilots on one of the large planes of Eastern Air Transport the other day. We believe we have sounded this warning before but it seems that we had better repeat it. These mechanical pilots may be all right to use on a mail plane or cargo carrier, but a company operating passenger transports is running the risk of losing its entire feminine clientele if they attempt to operate with them. The robot may fly the plane much more smoothly and accurately than the human pilot, but it won't look nearly so well in a uniform with wings on its chest.

Mr. Sikorsky's new flying boat, designed for use on the Pan American line, has set an important record already although it has been down only a few hours. The description accompanying the first pictures of it in the newspapers state that it is carrying an electric stove, without adding "for the first time in history." We believe that this is the first time in history that an electric stove has not been carried in an airplane for the first time in history.

"PARACHUTES SAVE LIVES OF PAIR DURING 'DOG FIGHT'"—headline in Buffalo *Evening News*. From this headline, the Girl Friend seemed to have arrived at the conclusion that the seat-type parachute had saved a couple of fellows from being bitten in the usual vulnarable spot, but we were finally able to convince her that this was a different sort of dog fight.

A few years ago we were at one of the eastern fields, talking to one of the old timers in the business of flying, when a plane passed overhead with advertising painted on its wings and with a loud siren blowing. The old-timer remarked that he had never expected to see the day when an airplane would have to blow a horn to attract attention, and it was a sad day in aviation for him. Having this remark in mind we'd like to hear his comments on an item we found in an aeronautical newspaper yesterday, to the effect that a group of people were attracted to an airport recently by "a barbecue and parachute jumping exhibition."

The following communication from L. W. F. of Milwaukee, Wis., sounds a warning to his fellow pilots:

"The enclosed clipping should be read with interest and viewed with alarm by every pilot. It was found in a Chicago paper and the statement made is apparently quite in a serious vein, since no cartoon or other indications of humor accompany it."

The clipping states: "The Rev. G. N. Woodley, pastor of a Roman Catholic church near Newark, N. J., gets a pilot license and plans to do missionary work among fivers."

A really clever aeronautical publicity man is never bothered by a depression, however severe. He can always produce facts and figures to show that things are just great with his outfit. Consider the report of an airways company operating near Prince Albert, Sask., Canada. "The company's tractors, teams, and airplanes transported more than 500 tons of freight into northern Saskatchewan during the 1930-31 season."

Mr. C. F. M. of Dunnedin, Fla., sends in an interesting clipping from the Tampa *Sunday Tribune* of a recent issue. The clipping is of a description of the plans of a new 'round the world flight. "The former broker, whose first flying lessons were taught him by Ruth Law, daring aviator of early day aviation—has selected a twin-motored sesquiplane powered by two Isotta-Fraschini engines cooled by glycothymoline."

As many of our readers probably didn't see the article about it in the Corning (Cal.) *Observer*, we take the liberty of reprinting the following information on one of the latest aeronautical instruments developed.

"While not chasing grasshoppers and mice, Cleopatra' puts in flying time in the air with Ben Torrey, manager of the Corning Airport. Her boss thinks he has made a discovery which will help make flying safer and at the same time more economical. Today he explained the new flying principle. Pilots who have had compasses stolen wilfully will find the flying cat quite economical. A good compass costs about $80 while a good grade of house cats can be obtained for 80 cents a dozen. The cat principle involves the following points. (1) A cat always has its head pointed toward the home port regardless of the weather conditions, (2) in fog and clouds when a pilot cannot get a horizon and loses his sense of feel and the plane is bottom up, the cat is right side up, (3) the cost of upkeep is low, as about the only equipment needed on cross-country trips is a bird cage, a pound of hamburger and a can of milk."

Further on in the article it is stated that Mr. Torrey has not patented his idea, dedicating it, rather, to the flying fraternity, but he adds the warning that some further flight testing is needed to make absolutely sure of the new instrument.

The pilot returns home after setting a new endurance record—

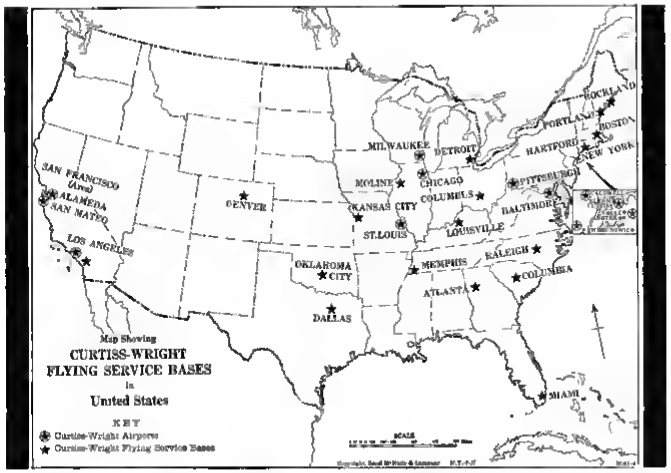
Pilot's wife: "Say, where have you been for the last three weeks?"

Pilot: "Just fueling around, my dear, just fueling around."

There, there, now. Don't get so excited—it's not very often we put in anything like the foregoing. Cancel your subscription if we do it again, but not for the first offense.

There hadn't been any news for such a long time from C. F. McR., our demon correspondent on the Pacific Coast, that we sent a note out there to inquire how come? He wrote back that the news item quoted below had completely stopped him and he was sorry he had ever boasted about the feats of the California aviators.

A strong right arm saved the life of T—R—, pilot, who was flying near Kingston, Canada. R— noted that the braces supporting one wing had come loose from the center support. He used his arm for a brace, looping it around the wing supports and made an emergency landing in a field.



These Curtiss Wright Flying Bases offer a nation-wide service with heated hangars, machine shops, the finest of facilities for airplane inspection or repair and a complete stock of over 4,000 parts and accessories.

TEXACO MARFAK GREASE

used at all Curtiss-Wright Flying Service Bases . . .

In line with the high type of service offered at Curtiss-Wright Flying Service Bases, Texaco Marfak Grease is used and recommended for rocker arm lubrication and for all enclosed grease-packed bearings.

Texaco Marfak Grease is a most unusual lubricant. It is made under the direct supervision of the world's foremost grease-maker. There is nothing like it. Texaco Marfak Grease has exceptional heat-resistance. It lasts longer and can be depended on for the effective lubrication of rocker-arm assemblies under every condition. This lubrication has always been a problem. Texaco Marfak Grease has solved it.

Texaco Marfak Grease, Texaco Aviation Gasoline and Texaco Airplane Oils are available at principal airports and landing fields throughout the country.

Curtiss-Wright Mechanic Servicing a Plane

TEXACO AVIATION GASOLINE
TEXACO AERODIESEL FUEL
TEXACO AIRPLANE OILS
TEXACO MARFAK GREASES
TEXACO ASPHALT PRODUCTS
FOR RUNWAYS, HANGAR FLOORS AND APRONS, AND DUST LAYING

THE TEXAS COMPANY · 135 East 42nd Street, New York

"Mud conditions very bad..."

WE EQUIPPED ALL OUR TRANSPORT PLANES WITH AIRWHEELS"

says NORTHWEST AIRWAYS

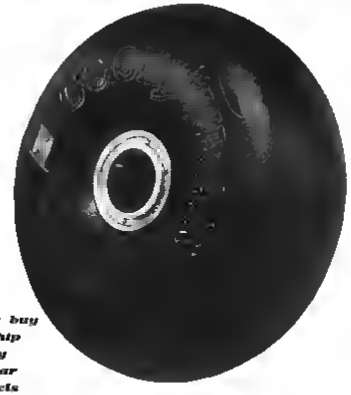
THERE was a time when one soft landing field in a chain of passenger transport stops could tie up air transportation.

But field conditions don't make much difference when your ship is equipped with Airwheels, as this letter from Northwest Airways demonstrates:

"Last February we opened our line from St. Paul to Pembina, North Dakota. Having operated in that territory before we were aware of the fact that mud conditions in the spring were very bad. To counteract this we equipped the Hamiltons on this line with Goodyear Airwheels. The service that the Airwheels gave us on this line was so satisfactory that we have since equipped all of our Hamiltons with them.

"We firmly believe that the use of these Airwheels has decreased the maintenance cost on our Hamilton planes and has also very much increased the comfort of the passengers riding on these ships."

GOODYEAR



When you buy a new ship specify Goodyear Airwheels

With the winter ahead—it will pay you to find out now what Airwheels can do to give your ships greater safety in landings on snow and muddy fields—how these great soft cushions can eliminate many of the minor hazards of take-off and landing under tricky weather conditions.

Only Goodyears can give you Airwheel safety.

EVERYTHING IN RUBBER FOR THE AIRPLANE

Successive Year!

Warner makes a clean sweep at National Air Races

Warner's Record for 1931 . . .

Transcontinental Handicap Air Derby
Santa Monica, Calif. to Cleveland
1st Phoebe Omlie Warner-Monocoupe
3rd in Women's Division—Martte Bowman, Warner-Inland Spirit
3rd in Men a Division—Eldon Cessna Warner-Cessna

Speed and Efficiency Contest for Single Motored Planes
1st Eldon Cessna Warner-Cessna
2nd Walter Carr Warner-Cessna

Men's Events
510 cu. in. free-for-all
1st John Livingston Warner-Monocoupe
3rd Vernon Roberts, Warner-Monocoupe

510 cu. in. A. T. C. Race
1st John Livingston Warner-Monocoupe
2nd Vernon Roberts Warner-Monocoupe
3rd Peter Brooks, Warner Monocoupe

650 cu. in free-for-all
1st John Livingston Warner-Monocoupe
3rd Vernon Roberts Warner-Monocoupe

650 cu. in. A. T. C. Race
1st John Livingston Warner-Monocoupe
2nd Vernon Roberts Warner-Monocoupe
3rd Peter Brooks Warner-Monocoupe

800 cu. in free-for-all
2nd John Livingston Warner-Monocoupe

800 cu. in. A. T. C. Race
1st John Livingston Warner-Monocoupe

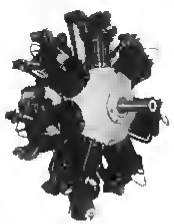
1000 cu. in A. T. C. Race
2nd John Livingston Warner-Monocoupe

1200 cu. in A. T. C. Race
1st John Livingston Warner-Monocoupe

Women's Events
510 cu. in. free-for-all
1st Phoebe Omlie, Warner-Monocoupe
3rd Maude Tait Warner-Gee Bee

650 cu. in. A. T. C. Race
1st Phoebe Omlie Warner-Monocoupe
3rd Maude Tait Warner-Gee Bee E

In the 1931 Ford Reliability Tour, Warner-powered planes led all single-engined entries, placing first and second in this classification, winning The Great Lakes Trophy for the second consecutive year



Warner's achievement this year is particularly brilliant. For not only did Warner with 422 cu. in. displacement, win every event in its power class, but captured as well the 800 and 1200 cu. in. events.

It is important to you to know that the same stamina, reliability and sound engineering essential to the winning of races is inherent in the Warner-Scarab engine that you buy.

Warner performance, day in and day out, is just as dependable, just as consistent as has been Warner's performance from year to year in the National Air Races.

WARNER AIRCRAFT COMPANY, DETROIT, MICHIGAN

WARNER "Scarab" ENGINES

FIRST *non-stop*
trans-Pacific Airplane Flight

made with dependable
CHAMPION
Spark Plugs

Hugh Herndon (left) and Clyde Pangborn (right) upon landing their Champion equipped Bellanca plane after the first non-stop trans-Pacific flight waved "Champion Aero A Spark Plugs used on our Miss Veedol flying across both Atlantic and Pacific oceans, functioned perfectly in every kind of weather."

When Hugh Herndon and Clyde Pangborn landed their plane at Wenatchee, Washington, they completed the most difficult phase of their 'round-the-world flight, *and* the first non-stop Pacific crossing by plane. Despite adverse weather conditions they set a new record from London to Tokio. Most of the credit for this epoch making flight belongs to the fliers themselves.

Beset by protracted delays in Japan, the fliers never for a moment lost sight of their original objective. It is to their everlasting credit that they were the first to span the Pacific.

It is on epoch making events like the Herndon-Pangborn flight in which Champions dramatically demonstrate that they are Champions both in name and in fact.

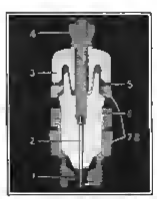
The demand for Champion Aero Spark Plugs from transport and mail lines and private operators, is constantly growing. The reasons are real and obvious.

The unique dual insulators of exclusive Champion Sillimanite—not porcelain—are so designed that they *cannot be broken in such a way as to interfere with engine operation.* In addition the design provides the maximum heat range so necessary for safety and dependability.

Install Champions in your ship and your conception of dependability will be boosted to a new high level.

CHAMPION
Aviation Spark Plugs

Toledo, Ohio • Windsor, Ont.



Champion Aero A Exclusive Features

• 1. Restricted bore. 2. Special analysis electrode. 3. Secondary sillimanite dome insulator. 4. Welded steel terminal. 5. Copper seal. 6. Primary sillimanite insulator. 7-8—Molded Copper gasket seals.

More than 3,000

SKF BEARINGS On U. S. S. AKRON

The World's Greatest Single Tribute to *Any* Bearing

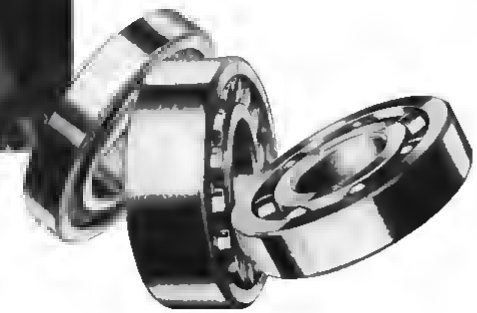
When the U. S. S. Akron soars aloft, her eight great Maybach motors turn on SKF Bearings . . . her control mechanism operates on SKF Bearings . . . her right angle propeller drives are equipped with SKF Bearings . . . her rudder hinges, elevators, ailerons, mooring spindle, all move upon SKF Bearings.

Throughout this new gigantic marvel of the air are more than three thousand SKF Bearings . . . the greatest single tribute ever paid to the design, the quality, the dependability of *any* bearing.

The same make of bearing was on the Spirit of St. Louis . . . the Columbia . . . the America . . . the Question Mark . . . the Graf Zeppelin . . . the same make of bearing has been on every ship of the air that has written aviation history across the skies . . . and selected solely upon the basis of PERFORMANCE!

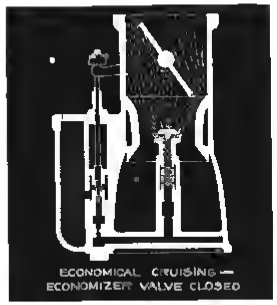
SKF Industries, Inc., 40 E. 34th St., New York, N.Y.

SKF
BALL AND ROLLER BEARINGS



Each of the eight 12-cylinder Maybach motors on the new U. S. S. Akron is equipped with 103 SKF Anti Friction Bearings. Even the portable mooring mast has SKF Bearings in the spindle that lets the great ship swing with the wind.

2774



ECONOMICAL CRUISING

MAXIMUM economy at part throttle or cruising speed has taken on a new meaning with the development of the Stromberg Aircraft Carburetor.

Two types of *Economizer Systems* contribute to this efficiency on Strombergs.

One is the *Needle Valve* type, the other, the *Piston* type. Both are operated by the throttle, both permit the carburetor to operate at maximum efficiency on a lean mixture at cruising speed and provide a rich, powerful mixture at full throttle.

Economical cruising is one of many reasons why Stromberg carburetors are used on over 95% of the aircraft engines now being built in the United States. Stromberg engineers will gladly help you with your own carburetion problems. Inquiries are invited.

STROMBERG CARBURETORS

BENDIX STROMBERG CARBURETOR COMPANY

«SUBSIDIARY OF BENDIX AVIATION CORPORATION»

701 BENDIX DRIVE · SOUTH BEND, INDIANA

STOP the RIVETERS

Hahn Spark Plugs stop ignition noises . . . widen your range of radio reception

IF your pilots have trouble picking up weather broadcasts, beacon signals or messages from your ground stations because of ignition noises... if their reception is not as clear with motors going as with motors stopped... consider the experience of the Eastern Air Transport Company.

A year ago the Eastern Air Transport equipped one of their planes with Hahn Radio Shielded Spark Plugs and a shielded ignition system as a trial installation. Now they have made Hahn standard on all their ships.

Eastern Air Transport found that Hahn Plugs cleared up ignition interference in both long and short wave reception. Equally important, they found that Hahn Plugs actually gave better engine performance. On their transport planes, the average life of Hahn Plugs has been over 500 flying hours... some have been flown over 800 hours. Servicing has only been required every 100 flying hours.

The Hahn Plug represents a long step forward in spark plug design. The large area of the Hahn electrodes prevents burning away and assures a constant gap. The large center electrode acts as a baffle and prevents fouling. The plug will not preignite in a hot engine. In addition, it is moisture proof and can be used with any type of harness.

We will gladly send you complete details upon request.

Walter Kidde & Company, Inc.
140 Cedar Street
New York

HAHN *Radio-Shielded Spark* PLUG

The World that NAVY CORSAIRS *See*

Vought *Corsairs* see the world with the Navy. For *Corsairs* are always with the fleet—wherever it may go.

In service with the aircraft carriers, *Corsairs* take off from steel decks—which are often far from steady runways—and land into relentless arresting gear. *Corsairs* are catapulted from the battleships and cruisers. They land in rough and choppy seas and are hoisted aboard by cranes. Service like this demands stamina and handling qualities far beyond the requirements of ordinary flying. And the way the *Corsair* meets such demands has made it a standard observation plane of the U. S. Navy.

Combine the structural strength of the *Corsair* with its exceptional speed range and ease of handling and you have a plane ideally suited for fast executive transport and private flying. Chance Vought Corporation, Division of United Aircraft & Transport Corporation. East Hartford, Connecticut. Export representatives: United Aircraft Exports, Inc., 230 Park Avenue, New York, N. Y.

CHANCE VOUGHT CORPORATION

PENNZOIL *for winter*
lubricates instantly
costs less per hour

Ask for PENNZOIL—
Not just "Pennsylvania Oil"

Oil that congeals in cold weather puts a drag on your motor. It reduces power when you need power most—in climbing.

Pennzoil flows and lubricates perfectly the minute you start your engine.

It doesn't break down after a few hours' flying like thinned winter oils. It gives you many extra flying hours with every refill. It costs less per hour. For perfect lubrication, for economy—fill with Pennzoil for winter. You'll like it.

The PENNZOIL COMPANY: Executive Offices and Refinery: Oil City Pa.
Division Offices: New York, Chicago, Los Angeles
British-American Oil Co., Ltd., Sole Distributors in Ontario and Quebec, Canada

100% PURE PENNSYLVANIA
PENNZOIL
SAFE LUBRICATION

PENNZOIL is made by the famous Pennzoil Process from 100% pure Pennsylvania crude and nothing else.

PERMIT NO. 2—PENNSYLVANIA
ORIGIN CRUDE OIL ASS'N

LEADERSHIP

All the commanding resources of Bendix, all the Bendix enthusiasm for sheer excellence of product, all the Bendix purpose to serve Aviation constructively — these are epitomized in every single Bendix Wheel and Brake for aircraft.

Bendix Airplane Wheels and Brakes originally were and still are designed for leadership—in strength, durability, dependability; and in meeting the practical needs of modern aircraft operation.

BENDIX BRAKE COMPANY
SOUTH BEND, INDIANA
(Subsidiary of Bendix Aviation Corporation)

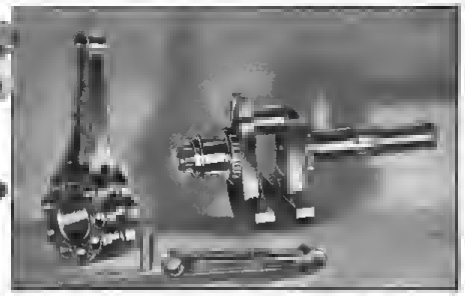
BENDIX FOR AIRPLANE WHEELS and SAFETY BRAKES

FULLY PROTECTED BY PATENTS AND APPLICATIONS IN U. S. AND ABROAD

Air Mail Saves Time

Packard Diesel aircraft engine manufactured by the PACKARD MOTOR CAR CO., Detroit, Mich. (Below) Nickel Alloy Steel master rod, link rod, link rod pin and crankshaft used in Packard Diesel engine.

Dependable materials are the best assurance of dependable performance



PACKARD Diesel . . . *the new idea in aircraft engines . . . uses tried and tested*

NICKEL ALLOY STEELS

IN the successful adaptation of Diesel power to radial aircraft engines, the Packard Motor Car Company has contributed a new and revolutionary chapter to the history of aeronautical progress. In spite of the radical—and ingenious—variations from conventional design embodied in the Packard Diesel engine, Packard engineers have adhered to the most conservative principles in the selection of materials. Nickel Alloy Steels are used for the crankshaft, connecting rods, link rod pins, cam, piston pins and starting jaws.

If materials superior to Nickel Steel had been available for these highly stressed parts, Packard would have employed them. As it is, the reliability and safety inherent in the Diesel principle are enhanced to the maximum extent by the use of Nickel Alloy Steels which have long since proved their dependability in practically all aircraft engines of the conventional type.

Nickel
FOR ALLOY STEEL

Send for List of Available Publications on Nickel and its Alloys

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

"SEEING" THROUGH FOG

5,000 FEET THICK

Here's a battery that was made to fly. The Exide Aircraft Battery is light-weight—compact—safe

Dependable Exides keep radio communication alive—make for safe landings

"YOU'RE over hangar five," reports the voice from the ground. And the pilot spirals down through the fog with confidence. A few minutes later—happy landing.

Exide Aircraft Batteries help make radio communication certain. And they supply steady power for landing, navigation and instrument lights—starting and ignition. Exides are designed for minimum weight. They assure absolute dependability. Moreover, the electrolyte will not spill.

Ask any pilot about Exide reliability. Write today for further information. One-seater "mono" or transcontinental air liner—there's an Exide Aircraft Battery to fill the bill.

Exide
AIRCRAFT
BATTERIES

Contractors to the U. S. Army and Navy

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
THE WORLD'S LARGEST MANUFACTURERS OF STORAGE BATTERIES FOR EVERY PURPOSE
Exide Batteries of Canada, Limited, Toronto

Reproduced above is an aerial view of the modern plant of the Sikorsky Aviation Corporation, at Bridgeport, Connecticut

SIKORSKY

In 1910 Igor Sikorsky had the extreme satisfaction of test-flying his first plane, the S-1. During the 21 years which followed that successful initiation Sikorsky designs have shown a fine combination of genius with advanced aeronautical engineering. The application of this combination to the most modern of manufacturing methods has resulted in the use of the name "Sikorsky" as a synonym for the highest type of amphibion airplane.

Some 200,000 sq. ft. of floor space are included in the Sikorsky plant, which is as modern in construction, arrangement and equipment as the Amphibions it produces. Included in this great establishment is a complete Experimental Laboratory for research into and the proving of various elements of aircraft design and manufacture. An essential feature of this aeronautical laboratory is the Vertical Wind Tunnel—the first of its type in the United States.

MANUFACTURERS OF AMPHIBION AIRPLANES FOR MILITARY, NAVAL, TRANSPORT, COMMERCIAL AND PRIVATE USE

Sikorsky Amphibions—every one a worthy bearer of the famous "Winged-S"—are available in four models: the S-39, carrying five persons; the 10-place S-38, the S-41, which accommodates 16, and the S-40 for 40 passengers. For detailed information on any or all of these models, address Sikorsky Aviation Corporation, Bridgeport, Connecticut. Division of United Aircraft & Transport Corporation.

WORLD'S RECORD FOR SPEED WITH LOAD

SIKORSKY AMPHIBION

WORLD'S RECORD FOR ALTITUDE WITH LOAD

Top *OVERHAUL*

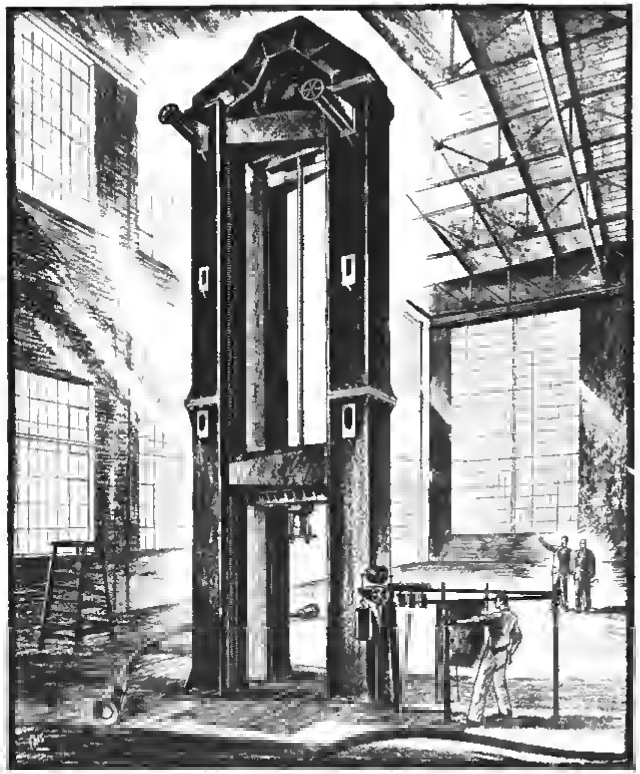
NO excessive carbon or scored cylinder walls here . . . valves clean, too. That's what a top overhaul reveals when an airplane engine has been lubricated with Socony De-waxed Motor Oil and fueled with Socony Aviation Gasoline. A minimum of carbon indicates there has been no engine overheating or loss of power.

No wonder Socony Aviation Gasoline and Socony De-waxed Motor Oil are pilots' choice in New York and New England. We gather first-hand experience in fueling and lubricating our own Test Plane. Then our own aviation experts air-tailor these products for flying conditions you yourself encounter. Fly with Socony next time.

SOCONY

AVIATION GASOLINE DE-WAXED MOTOR OIL

STANDARD OIL COMPANY OF NEW YORK



No. 13 of a series of advertisements on "How Superlative Quality is Built into Roebling Wire Products"

A *Tower of Torture* for Wire Rope

A 3¾ inch rope is "on the rack". A lever is thrown. The massive screw columns slowly turn. The rope draws taut . . . now you begin to see its mettle. 500,000 lbs. tension! 1,000,000 . . . the wires begin to snap! Finally . . . an ear-splitting report . . . and the broken strands lash back from the break.

So goes one of Roebling's regular routine specification tests on this giant Riehle testing machine, built originally to test the huge cables for the George Washington Bridge. It is one of the largest precision testing machines in the world, 2,500,000 lbs. in capacity, 43 feet high, 138 tons in weight. It tests by compression as well as tension . . . can crush a 15 foot cast iron column, 15 in diameter, with 1¼ walls! This formidable machine marks one extreme to which Roebling goes in testing wire and wire rope. At the other extreme are midget machines to test wire under a few ounces of tension. And in between are machines of every conceivable type and size. To make certain that in Roebling Wire Products there will be a maximum of strength, stamina and safety, no stone has been left unturned.

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ROEBLING WIRE AIRCRAFT PRODUCTS

Mr. Francis Arcier, Chief Engineer, Waco Aircraft, reports on . . .

Where and Why WACO uses Self-tapping Screws

to make better assemblies at lower cost

Many airplane design and production men will be interested in the following summarized report on where and why Waco uses Self-tapping Screws. It may point to opportunities to simplify more of their own metal assemblies with these unique screws.

Wood fairing strip attached to longeron—Simply by turning Self-tapping Sheet Metal Screws into holes drilled through both wood strips and tubing. Strips formerly fastened with electrical tape which frayed and cut . . . was not neat . . . required much more time and several pounds of tape.

Floor off set fastened to longeron—Durol off set support is fitted over bottom of longeron member to support floor. Holes are drilled through off set and longeron and Self-tapping Sheet Metal Screws are turned in. This method is light, cheap and secure. To fasten off set with welded lugs would be too costly, and machine screws or bolts and nuts would weaken longeron.

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Cover fastened to metal seat back—Durol cover fastened to seat back by drilling holes in both units and turning in Self-tapping Sheet Metal Screws. To use bolts and nuts would increase weight and cost.

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For joining and making fastenings to sheet metal up to six gauge; also aluminum die castings, Bakelite, etc. Simply turn Screw into drilled, pierced or molded hole. It forms a thread in the material as it is turned in. Can be removed and replaced.

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Send me free booklets on the Security and Economy of assemblies made with Self-tapping Screws

Name and Co. ---

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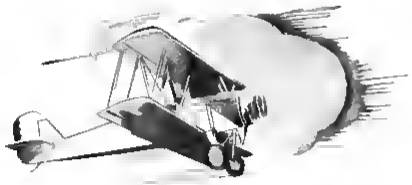

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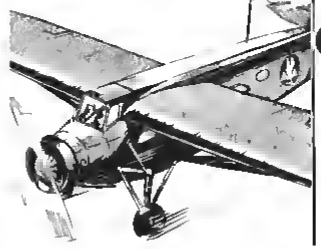

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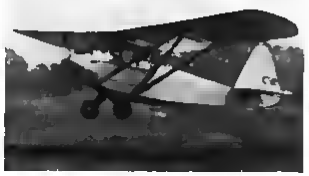

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Continuous check of the performance of the eight mighty engines of the U. S. S. Akron—new Giant of the Air—is given by Weston Tachometers. The R. P. M. of the engines is directly indicated on the instrument panels. This means closer, more convenient supervision—greater overall operating efficiency.

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Designed to meet the practical requirements of modern flying, the selection of Weston Tachometers for the U. S. S. Akron—the greatest achievement in aircraft development—is a marked tribute to the reliable, accurate, and trouble-free operation built into these instruments by Weston engineers

Features of Weston Tachometers

1. Accurate, steady, dependable indications
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7. Indicators give 270 deflection over 5½ inch scale
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9. Fully shielded to prevent interference with magnetic compass or radio.

Model 544 MAGNETO GENERATOR weighs only 1 lb. 5 oz. Screws directly on engine SAE tachometer outlet Connected to indicator by small wires.

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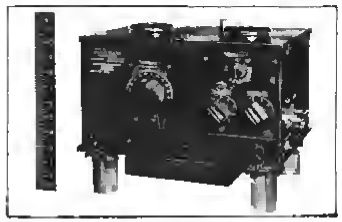
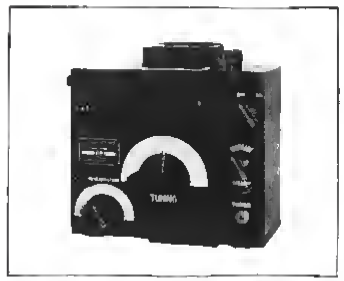
RCA's two-way aircraft radio equipment is absolutely dependable. It works every time you press the button. Aside from its unerring dependability it is the lightest, simplest and most compact aircraft radio apparatus ever offered.



Type R Radiophone and telegraph transmitter for mounting anywhere in the ship to operate on any wave length between 50 and 800 meters Weight 10 lbs. 6 ozs. Price $1,000 f.o.b., New York



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This combination radiophone and telegraph apparatus was designed for both transport and itinerant service and is especially recommended for use on planes which could not formerly carry voice communication equipment because of weight or space limitations

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AIRCRAFT SERVICE DIRECTORY

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FOR SALE, American Cirrus upright 90 hp. motor. In good running order. First $225.00 takes it. Brown Metalplane Company, Spokane, Washington.

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GEE BEE Sportster Model E, Warner powered. Less than two hundred hours. Perfect condition. Z. D. Granville, Springfield, Mass.

FOR SALE, New Standard D-25, 5 place Wright J-5, A-1 condition. Will finance. Never cracked. Price right. Inquire FS-140, Aviation, 330 West 42nd St., New York.

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Privately owned four, five and six place

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HISSO EAGLEROCK—Newly recovered. Engine A1 condition. Priced for quick sale. N. C. license. Van Hoffmann Aircraft Co., Robertson, Mo.

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Kinner K5 with only 35 hours, first motor the same as new. Factory list $1,800. Our price $480.

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40 Spartan 3-place, excellent condition, want Mono Coupe or light plane.

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4. **Travelair** 3-place Wright Whirlwind, completely rebuilt as deluxe job for Department of Commerce inspector who just lost life in automobile crash, recovered, relicensed, engine factory rebuilt, full set instruments, compass, bank and turn, Bendix wheels and brakes, Eclipse starter, Standard Steel Propeller — a rare bargain at $2950.

5. **Engines** — New and Used. Factory Rebuilt Pratt & Whitney Wasps & Hornets, Wright Whirlwinds, nearly new and factory overhaul $500, also Standard Steel propellers for same. Wright Cyclones 575 hp. brand new, never used, two at price of one.

6. **Many Other Outstanding Values** — 3-place Savoia Amphibions, small Sikorskys, Inland Trimotor, 10-place late Fokker F-7 trimotor, rebuilt, factory overhauled engines, at only $1000. Stinson Junior Lycoming nearly new at $2950. Bird 3-place, both 100 and 125-hp. Kinners, also Warner engine. Stinson Junior at $1500. Warner Engine Fleet special job property million-dollar sportsman, guaranteed total time on ship 31 hours, with brand new Warner Scarab engine at $2650. Monocoupes, Monoprops, Moths, AVRO AVIANS, WACO-10 with OX Miller Head engine, Scintilla magneto, excellent condition $800.

7. **Buhl Airsedan** — Wright Cyclone 575-hp. engine, 150-mile top speed, 2500 lb. pay load, perfect condition. Refinished, relicensed. Price $3350.

WANTED! Curtiss Junior or American Eaglet in first-class condition, also one Whirlwind half-place Standard and other ships, all classes, if in A-1 condition and priced right for quick cash sales.

Phone or write your requirements. Let me inspect, test and give you honest reliable report on your prospective purchase, or sell your ships for you. Flight testing — all types of ships — and Aviation insurance, all classes. Private field and Hangar for storage. Phone or write Geo. E. Post, Test Pilot, Post House, 261 11th Ave., New York City. Phone Regardus 1-2833.

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Wire or Write for Prices

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WACO DEALERS

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Brand new OX5		$198.50
Szekely, used 15 hours		295.00
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Acetate Dope	gal.	.98
26x4-in. Goodrich Tires	ea.	2.95
24x4-in. Goodrich Tubes	ea.	.97
24x4-in. Wheel, Tire and Tube complete		9.95
Flightex Airplane Fabric	per yd.	.57
Pioneer and Pathfinder Compasses	ea.	18.75
A. N. Aircraft Bolts	ea.	.02 and up
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KARL ORT, York, Pa.

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300-hp. Wright Whirlwind-motored 6-place Model 6000B Travel Air Cabin Monoplane, equipped with landing lights and flare, total 140 hours, very carefully flown, dandy condition, price when new $13,750; our price only $4,950.

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Largest in the Middle West
111 Crosbie Arc Bldg., Kansas City, Mo.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

Of Aviation, published monthly at New York, N. Y., for October 1, 1931.

State of New York } ss
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared C. H. Thompson, who having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company Inc., publishers of Aviation, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher McGraw-Hill Publishing Company Inc., 11th Ave. & 37th St., N. Y. C. Editor Edward P. Warner, 10th Ave. & 38th St., N. Y. C. Managing Editor Leslie E. Neville, 10th Ave. & 36th St., N. Y. C. Business Manager Louis F. Stoll, 1711 Ave. A, 11th St., N. Y. C.

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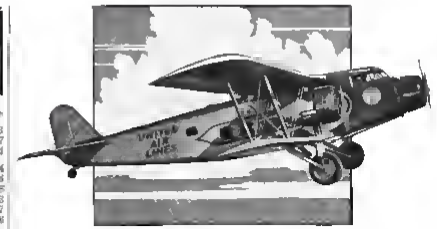

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The United Air Lines has just completed 35,000,000 miles in the air; 15,000,000 of them at night.

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United Air Lines has standardized on Wasp and Hornet engines, each one Scintilla equipped. Naturally, we're proud of the fact. Selection of Scintilla Magnetos is a realization that the reliability of an aircraft engine is dependent upon unfailing "spark."

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DEPENDABILITY SIMPLICITY ACCESSIBILITY

A "ROBOT"—*and* STANAVO—

flew this

E. A. T. plane

Spectators at Newark Airport recently watched attentively as one of Eastern Air Transport's Condors, powered by two 61 compression Conqueror engines, was flown smoothly and accurately for twenty minutes, without the aid of human control, by a robot pilot. Level flight and a true course were maintained by a mechanical device known as the Sperry automatic pilot—a striking demonstration of modern engineering ability and dependable mechanism.

In the less spectacular, but equally striking dependability of E. A. T.'s daily operation of a 12,000-mile schedule, the efficiency of its equipment gives a similar demonstration of reliability, maintaining prompt and regular flying schedules up and down the Atlantic seaboard.

Dependable engine operation, which is essential to any air transport system, requires an ever ready supply of uniform high-quality aviation gasoline. Like other systems, Eastern Air Transport uses Stanavo Aviation Gasoline in all its airplanes, from the smallest mail plane to the great Curtiss Condors carrying 18 passengers and crew of three.

H. A. Elliott, of the Eastern Air Transport Company, testing the control action of the robot.

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Alike to a Split Hair in Every Detail

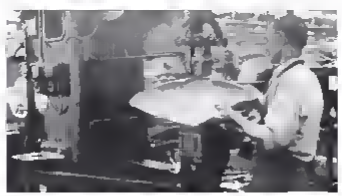
Production line methods and precision manufacture explain why Martin replacement parts always fit

JIGS and fixtures for important parts made on machinery accurate to ten thousandths of an inch. Equipment for shearing aluminum alloy sheet in 14-foot lengths with a tolerance of only .003". All layout and inspection tables of heavy cast iron with machined surfaces accurate to .0005". These are but a few random examples.

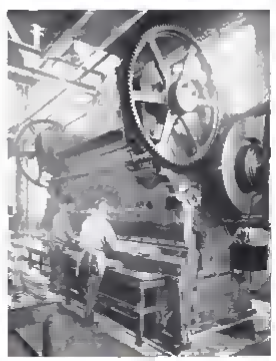
Nowhere else in the industry will you find so much special equipment for precision manufacture as in the Martin plant. Nothing that can be made more accurate by machinery is ever done by hand.

This explains why Martin replacement parts always fit accurately into place—why the parts of any Martin plane are immediately interchangeable with the parts of any other Martin plane of the same type. Nowhere else in the industry can aircraft of equal quality be produced in quantity at lower cost.

The GLENN L. MARTIN CO.
BALTIMORE MARYLAND
Builders of Dependable Aircraft Since 1909



Highly accurate equipment used in production means that no exact duplicate of any part of any Martin plane is always readily obtainable. Result: Time and money saved in overhaul or repair.



Accurate manufacture of every part reduces assembly costs. It also permits assembly with small tolerances thereby minimizing wear on moving and stressed parts and lowering cost of maintenance.

★ ★ ★

Built with the utmost precision, such replacement parts as rudders, elevators, ailerons, wheel guards, floats, tanks, wing panels, etc., always fit accurately into plane when needed.

MARTIN AIRCRAFT

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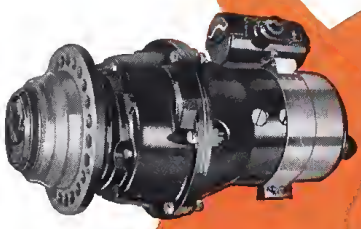
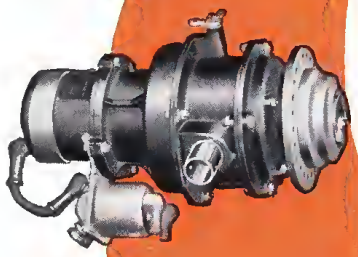
AVIATION ENGINE STARTERS and GENERATORS

—bear the stamp of approval

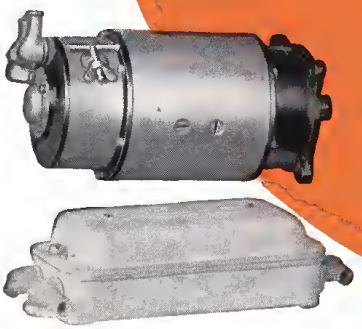
The selection of Eclipse Products for daily use on nearly all transport lines in America is a tribute to the performance demanded and received from Eclipse equipment.



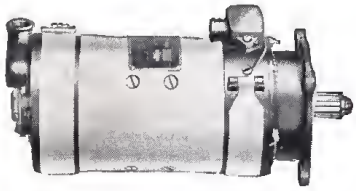
Eclipse type E160 direct cranking electric starter for engines up to 1350 cubic inch piston displacement.



Eclipse, Series 6, Combination Hand and Electric Inertia Starter with Solenoid Switch. Concentric type for radial engines up to 1350 cu. in. piston displacement.

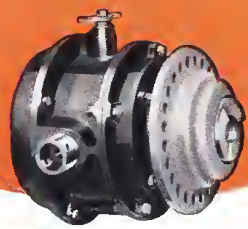


Eclipse voltage-regulated genetator, 15 volt, 25 ampere capacity, engine drive type with control box.

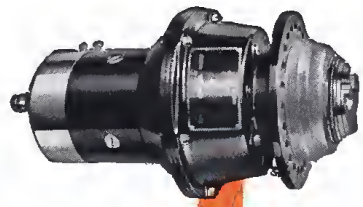


Eclipse type M-B double voltage, voltage-regulated radio generator engine driven.

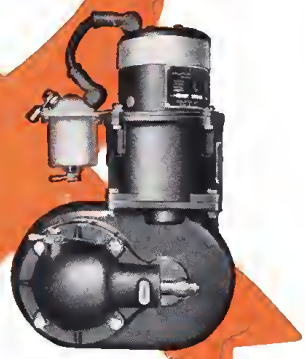
Eclipse direct cranking electric starter, type [illegible], for engines up to 450 cu. in. piston displacement.



Eclipse, Series 11, Hand Inertia Starter, concentric type for engines up to 2500 cu. in. piston displacement.



Eclipse direct cranking electric starter, type F-141, for engines up to 800 cu. in. piston displacement.



Eclipse, Series 7, Combination Hand and Electric Inertia Starter with Solenoid Switch. Vertical type for V type or radial engine up to 2500 cu. in. piston displacement.

Eclipse aviation dynamotor type "A"

ECLIPSE AVIATION CORPORATION

East Orange, New Jersey

(Subsidiary of Bendix Aviation Corporation)